An analysis of conformation and performance variables in potential three day event horses in Ireland

An Analysis of Conformation and Performance Variables in Potential Three Day Event Horses in Ireland

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Abstract

Eventing is the ultimate test of speed, endurance, obedience and athleticism and the importance of such qualities in horses date back to cavalry times where such attributes were deciding factors in wars. The Irish Sport Horse is the leading studbook for eventing for the last 15 years (WBFSH, 2009). In order to keep the Irish Sport Horse at the top of this sport, talented animals have to be identified early. To identify elite horses early, studbooks all over the world employ conformation assessment as an indicator for pre-selection and suitability. Since the new format of eventing was introduced, opinions on what type of horse is suitable for the sport are divided. Currently in Ireland, selection of young event horses is not carried out by any of the studbooks. The Future Event Horse League (FEHL) offers owners of potential event horses a competition to test their abilities. The league is run in a different format to eventing, and as part of the competitions, judges score the potential of the horse for this particular sport. One objective of this study was to analyse selection methods for young event horses in Ireland. Data from competitions of FEHL were analysed in order to evaluate conformation and suitability of the horses that took part and the consistency of the judges scoring. An additional aim was to provide an overview of the conformation of horses produced for eventing in Ireland. For this purpose, 2 years of conformation evaluation on horses competing in the FEHL was carried out. The last part of the study focused on the requirements of conformation and the type of horse suitable for the new short format of competition. Interviews with riders competing at Four Star level (highest level of competition event riders can progress to) were carried out. FEHL competitions consist of four phases. Three of four phases aim to assess the suitability and potential of a horse for elite level. These are the Suitability and Potential of the Ridden Display to indicate future performance in dressage, the Suitability and Potential of Conformation and Movement and the Suitability and Potential of Jumping. The fourth phase the Ridden Display consists of a ridden test similar to a dressage test. Intraclass Correlation Coefficient values demonstrated fair to almost perfect agreement amongst judges for the quality of horse in each phase of competition ($p < 0.05$), ranging from 0.370 to 0.952. Suitability and potential average scores the horses were awarded, failed to show significant differences between first and last qualifiers attended ($p > 0.05$). Ridden Display scores improved from the first to the last qualifier. The 5 year old age group scored higher average scores in every phase compared to 4-year-old horses ($p < 0.05$). Mares scored significantly lower in two of the four phases than geldings ($p < 0.05$). Analysis of variance between years showed that horses in 2008 scored significantly lower in Suitability and Potential of Conformation and Jumping compared to the four previous years ($p< 0.05$). Temperament was the most important selection criteria for event horses among elite riders. Irish Sport Horse crossbred with thoroughbred was considered the most suitable breed combination. The descriptive approach to conformation evaluation in this study highlighted a relatively high prevalence of some unfavourable conformation traits for eventing such as: straight shoulders, back-at-the-knee conformation, sickle hock conformation, long back conformation, weak loin area, rectangular structure and lack of impulsion in the trot. Based on interviews with competitors, it is apparent that selection criteria for event horses should be distinct from those used in the selection of showjumping horses.

Declaration

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Supervisor: Prof Sean Arkins
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This dissertation is presented in partial fulfilment of the requirements for Master of Science in Equine Science. It is entirely my own work and has not been submitted to any other university or higher education institution, or for any other academic award in this university. Where use has been made of the work of other people it has been fully acknowledges and fully referenced.

Signature

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Chapter One

Introduction

Chapter 1: Introduction

Eventing is a test of speed, endurance, obedience and athleticism and the importance of such qualities in horses date back to cavalry times where such attributes were deciding factors in wars. References to this date back as far as Xenophon who wrote in the art of horsemanship that “a horse which cannot endure fatigue will clearly be unable to overhaul the foeman or effect escape, and a horse that will not obey is only fighting for the enemy and not for his friends" (Morgan, 1962).

The Irish Sport Horse is the leading studbook for eventing for the last 15 years (WBFSH, 2009). In order to keep the Irish Sport Horse at the top of this sport, talented animals have to be identified early. Selection criteria for event horses need to be different than those for dressage or showjumping horses as the horse needs to able to negotiate all disciplines at the top level. To identify elite horses early, studbooks all over the world employ conformation assessment as an indicator for pre-selection and suitability. Since the new format of eventing was introduced in 2000, opinions on what type of horse is suitable for the sport are divided. Traditionally a predominantly thoroughbred horse was preferred to cope with the long format of competition. With the change in competition, requirements on conformation may have changed.

Conformation and performance variables in event horses are currently not assessed on a formal basis in Ireland. For this reason it is difficult to quantify what makes the Irish Sport Horse the leading event horses in the world. This in turn makes profiling them at a young age impossible and selection is largely based on trial and error. For these reasons it is clear that an attempt should be made to assess event horses at an early stage in their career and follow their progression in the sport. Very little research has been carried out regarding the requirements of event horses. With this lack of research, setting guidelines to select event horses early poses some difficulties. Out of this lack of formal assessment and knowledge regarding conformation for the highest performance level required in eventing, this study set out to attempt to profile the conformation requirements of the modern day event horse.

The Future Event Horse League (FEHL) runs competitions for young event horses that attempt to identify horses for eventing at a young age. FEHL provides set criteria for their judges to assess potential and suitability of horses to go on to advanced competition and judge them accordingly. Three of the four phases analysed are judging the suitability and potential of a horse for elite level. These are the Suitability and Potential of the Ridden Display to indicate future performance in dressage, the Suitability and Potential of Conformation and Movement and the Suitability and Potential of Jumping. The only phase not judging suitability is the Ridden Display, which is based on the execution of the set test. Data from the FEHL provide a resource to analyse scores achieved by potential young Irish horses, differences in gender and age group and reliability of judges used. The study set out to test the accuracy of scoring, evaluation of scores achieved by horses, and the potential effects that may influence their performance scores. An evaluation of the FEHL may provide feedback to event horse producers and studbooks on suitability and potential of horses brought forward and assessment methods employed. Furthermore FEHL provide a source of young horses thought to be suitable for eventing by professional producers and owners in Ireland. This allowed the study to carry out independent conformation assessment of a cohort of horses deemed suitable.

Young horse tests are carried out in every studbook and horses are judged in order to meet the breeding objective set out by the studbook and judges need to conform to these guidelines in order to make careful selection of performance and breeding stock (Holmström, 2001, Koenen et al., 2004).

Chapter Two

Literature Review

Chapter 2: Literature Review

2.1 Selection of Performance Horse

Horses have been selected and bred for specific purposes for hundreds of years. They were primarily selected on their durability and suitability for a specific purpose, such as for agriculture, where strength and endurance were key factors. The role of the horse has changed over centuries from that of a working and military animal to that of a sport and leisure animal. This, in turn, changed the breeding objectives where the need for a heavy type of horse diminished and selection moved forwards to a more athletic horse suitable for sports such as jumping, dressage, racing and eventing.

Several studbooks around the world set breeding objectives as to what type of an equine they aimed to produce and they have adapted selection strategies most suited to their specific criteria. According to Dubois and Ricard (2007) the Selle Francais has been selected mainly for show jumping over the last 40 years, based on competition results. These criteria applied to stallion selection only and all fillies born could become broodmares of the breed. Belgium applies similar practises by only using competition data to select Belgian Warmblood stallions. There are a series of competitions for young horses known as “Cycle Classique” where horses of the same age group compete against one another (Bruns et al., 2004). These and other studbooks such as Holstein and Irish Sport Horse emphasise their breeding goal to be show jumping, whereas others such as the Hannovarian and the Royal Warmblood Studbook of Netherlands (KWPN) have multiple breeding objectives and are therefore divided into subgroups such as dressage and show jumping. Most studbooks include performance scores of the major disciplines such as show jumping, dressage and eventing, with some specifying the level of performance at national or international level (Koenen and Aldridge, 2002, Bruns et al., 2004). While the Belgian and French selection process of performance horses is largely based on competition results, other countries include assessment of conformation, gaits and jumping, especially in the pre-selection stages of potential stallions. In Germany, Sweden, Denmark and the Netherlands this type of pre-selection is also used to evaluate riding horses of any gender early and score them accordingly. It is mainly carried out with 3 and 4 year old horses and additional traits other than conformation, gaits and jumping are usually assessed. These additional selection traits usually incorporate marks for riding ability, temperament and jumping under saddle (Huizinga et al., 1990, Viklund et al., 2005, Dansk Varmblod, 2008).

Bruns et al. (2004) further specifies that selection procedures of young horses in the main studbooks are largely carried out as station performance tests, field performance tests and/or competition tests.

2.1.1 Selection procedures in Ireland

In Ireland, stallions to be approved for the Irish Sport Horse Studbook are tested in a field performance test where conformation, movement, performance and a veterinary examination are carried out to pre-select potential stallions. Those selected go on to compete and accumulate points in show jumping, dressage or eventing and, only on acquiring adequate performance results, can be fully approved. For mares to be eligible to enter the Section A studbook, their sires need to be approved or be listed in the supplementary section and their dams need to be in Section A. The remainder are registered in Section B (IHB, 2009). While most of these selection processes concentrate on identifying suitable stallions for their studbook there are other competitions where all young horses of any gender compete to provide an indication of future success.

To select horses for specific areas of equitation, countries employ a variety of young horse competitions. As mentioned above, in France and Belgium they have the “Cycle Classique” for 4, 5 and 6 year olds. Germany holds a prestigious competition known as the Bundeschampionat in show jumping, dressage and eventing where young German horses display their talents. In Ireland there are Irish Horse Board show jumping competitions for 4, 5 and 6 & 7 year olds to attempt to highlight the best performance horses. The Future Event Horse League in Ireland holds competitions to identify the most suitable 4 and 5 year old horses for eventing. Similar competitions are held in England and France for young event horses. Some of these competitions determine which horses are sent to the world breeding championships held every year at Lanaken for show jumping, Le Lion d’Angers for event horses, and Verden for dressage horses (WBFSH, 2009).

2.2 Eventing

Eventing, in its new form, consists of three equestrian disciplines: dressage, cross-country and show jumping. Eventing in its original form included an additional phase known as roads and tracks. The winner is determined by the fewest number of penalties accumulated over the three disciplines. In the event of a tie, the cross country phase is the deciding phase (Eventing Ireland, 2008).

2.2.1 Format of three day eventing

The Federation Equestre International (FEI, 2007) fact sheet explains how the three disciplines are currently run. On the first day of competition a dressage test is carried out testing the obedience and harmonious development of the physique and ability of the horse. Although the dressage in eventing is not as demanding as that of pure dressage it is often difficult for a very fit event horse to concentrate on just trotting in a dressage arena, when a lot of the preparation to get to the top level involves fast work. The test involves a series of compulsory movements in walk, trot and canter in a 60 m by 20 m arena.

The second day of competition consists of a cross-country course over anything from 18 to 40 natural solid fences and a distance of 1600 m to 4000 m. The objective of this test is to demonstrate speed, endurance and jumping ability of the horse.

On the third day a compulsory “trot-up” is held, which is observed by veterinarians, to assess whether horses are sound to go on to the third and final phase, the show jumping. Horses may be withdrawn voluntarily by the riders if they feel the horse is not fit enough to continue. The objective of the show jumping is to prove that the horse retained enough suppleness, energy and obedience after the first two tests to negotiate a course of 10 to 13 knock-able fences.

2.2.2 Origins of three day eventing

The origins of three-day eventing are in Europe. It is largely of military origin where cavalry officers strived to devise a competition to test their horses. Even today, in some parts of Europe eventing is still referred to as military. Not unlike today, the format was similar with a dressage test to test obedience, followed by a test of stamina, speed and jumping across country and, to finish off, a round of show jumping to prove the horse was fit to continue even after a hard days work to mimic battle conditions (Sly, 1996, Eventing Ireland, 2008). One of the first recorded competitions in this format was held in France in 1902 and included 4 phases: dressage, steeplechase, roads and tracks and show jumping. In the Stockholm Olympics of 1912, eventing was included for the first time, where the cross country phase was of four hours duration. Sweden took the gold medal. In the new millennium the question arose as to how fair the long format was to the horses, as a lot of horses failed the final trot up and therefore failed to complete competition. As a result of this, and the threat of the discipline being dropped from the Olympics, most competitions post 2000 have dropped the steeplechase and roads and tracks section (Eventing Ireland, 2008).

2.2.3 Three Day Event Horses

The three phase nature of eventing requires event horses to be multi-talented animals. It is commonly agreed that a suitable horse for eventing must be courageous, careful, agile, a bold jumper, have the ability to gallop, be athletic, nimble, enduring, well conformed and have a good temperament or attitude. Bearing in mind that event horses at any level come in all sorts of shapes, sizes, colours and breeds, selection to one common denominator is difficult (Dalin and Jeffcott, 1994, Anon, 1999, Saastamoinen and Barrey, 2000, Holmström, 2001, McIlwraith et al., 2003, van Weeren and Crevier-Denoix, 2006). The above authors agree that personal preference and the level of competition is important when selecting a horse for the sport. It is generally agreed that one of the most important characteristics of an event horse is a good temperament and Sly (1995) states that a horse with a really good attitude but of moderate physique is often more successful than a horse that is physically talented but less co-operative. However, temperament or attitude is very difficult to quantify, resulting in a need to look at more measured aspects such as conformation, gaits and performance.

2.3 Conformation Evaluation

Conformation is the body shape, form or outline of a horse and refers to its outer appearance. It is described as the relationship between form and function. In many studbooks around the world it is used as an indicator of performance and the ability to stay sound (Stashak, 1987, Weller et al., 2006b).

Good and bad conformation have been described as early as 430 – 354 BC by Xenophon (Morgan, 1962), who identified key points of weakness and strength in conformation. Other early studies tended to concentrate on conformation of cavalry and draft horses and related them to performance. With the changing role of the horse in history, from a transport, farming and battle animal to a sport performance animal, conformation ideals had to be amended and new ones established. Marks (2000) notes that conformation should be judged according to the horse's purpose and, furthermore, what may be considered as being good conformation for one discipline may be bad for another. Poor conformation of limbs can contribute to lameness and may even be the cause of lameness and certain conformational parameters are associated with performance and injury risk (Stashak, 1987). Progression in any equestrian sport is hindered by lameness. Therefore conformation of limbs, in particular, when compared to body conformation and the proportions to one another can determine whether a horse is predisposed to lameness (Dyson, 2000). Additionally Magnussen and Thafvelin (1985) related orthopaedic health to soundness in Standardbred trotters in Sweden. A report on lameness in the sport horse (Stashak, 1987) states that the limbs and backs of event horses are placed under huge strains due to the extreme demands placed on the musculoskeletal system and competing on extremely variable terrain. Furthermore, horses with poor conformation are at even higher risk of injury.

As conformation varies between breeds, a common denominator seems to be balance (Stashak, 1987). Balance in conformation of the horse is evaluated by dividing the body into thirds; the forehand, the midbody and the hindquarters, with each part being proportional to all others (Beeman, 1973, Sly, 1995, Dolvik and Klemetsdal, 1999, Ross, 2003a, Love et al., 2006, Stock and Distl, 2006) as depicted in Figure 1. Inequality in any of these may be seen as weakness in conformation.

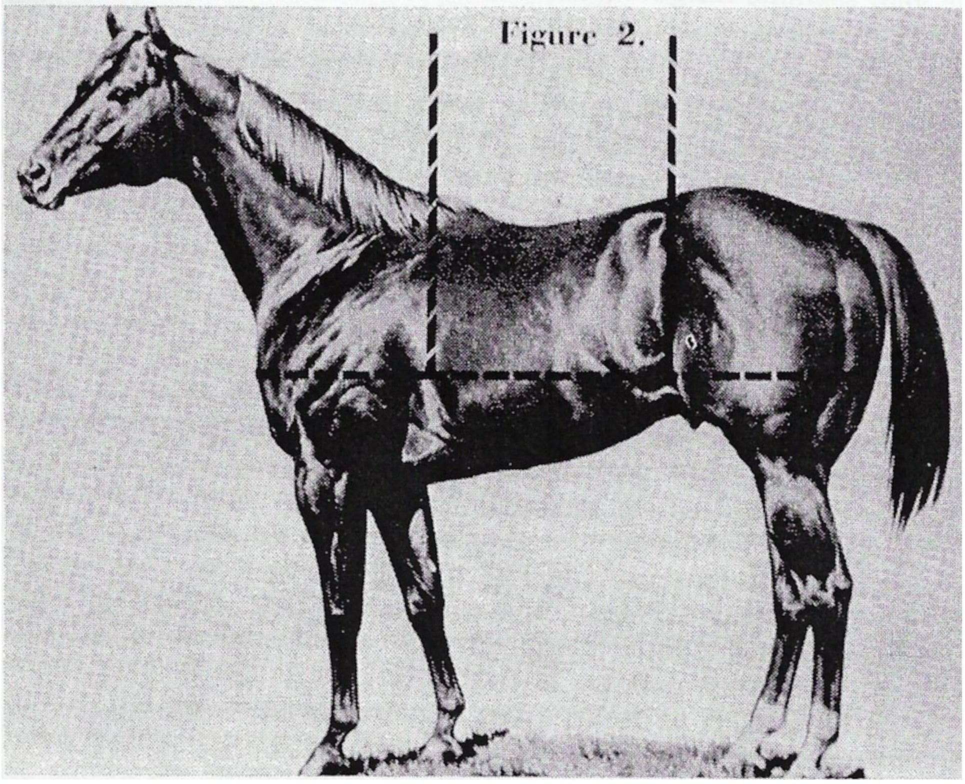


Figure 1: Balance in Conformation (Beeman, 1973)

2.3.1 Traditional Scoring of Conformation

Scoring of conformation in the traditional way involves giving a subjectively scored value to an aspect of conformation of the horse. The higher this numerical value, the closer to ideal that trait is considered. The ideal is defined as the breeding objectives in the particular studbook (von Lengerken and Schwark, 2002). Some of the breeding organisations describe traits such as a "noble, correct and beautiful horse", which makes objective evaluation very difficult to measure (Koenen and Aldridge, 2002). An advantage of such evaluation is the speed and number of horses that can be assessed within a limited timeframe and therefore this is the preferred method in horse conformation assessment (Saastamoinen and Barrey, 2000).

With different judging panels or individual judges, a different use of the range of scale can be observed. This makes it very difficult to observe any changing trends over time (Preisinger et al., 1991). Some studies report an only 60% use of the available scale of points. Another study reported judges only using 20% of available scores and the biggest range of a scale used was 90% (Breen, 2009). Due to different judges using varying amounts of the scale, classification differs, and actual differences in horses cannot be estimated (Holmström, 2001). Additionally the reliability of the evaluation depends on the skill and experience of the judge. The only way to overcome this is to have the same judging panel evaluate all horses, such as at stallion inspections or mare studbook inspections (Preisinger et al., 1991) .

Furthermore, traditional scoring does not describe a horse's conformation. It cannot be determined how a horse scoring lower points is different to one scoring highly. Considering that judges have to work off a fictitious ideal, some traits may be overrated and others underrated, especially if breeding goals have not been defined in very much detail. In a population of Hannovarian horses, the aim was to produce a horse that was an ideal "all-round" riding horse to be used for any equestrian discipline (von Lengerken and Schwark, 2002). When conformation scores from studbook inspection were correlated with performance test scores, every trait was significantly positively related to dressage ability and negatively correlated with jumping ability. Therefore their assessment of conformation and their breeding objective are not the same. Conformation assessment clearly identifies a horse that is more suitable to dressage and is not favouring an "all-round" horse that is meant to identify dual ability. This example clearly highlights the limitations subjective conformation assessment has and indicates the need for a more objective assessment method. Recently the Irish Cattle Breeders Association have introduced linear evaluation of traits in beef cattle scored on a traditional scale, where the maximum scale is represented by the 'ideal' in most traits (ICBF, 2010).

2.3.2 Linear Scoring of Conformation

The linear descriptive system developed as a tool in cattle breeding in the USA in the 1970's, when the National Association of Animal Breeders were looking for a suitable and unified system to evaluate offspring of bulls. They came up with 14 traits initially with a range of 50 points for each of them. After using it in the field it became evident very rapidly that the range was too wide and the differences between the different points were not informative about differences in the conformation. On introduction of linear scoring in cattle in Europe, scales of 1-4 and 1-9 were adapted for each trait (Rensing, 2004). The principle behind linear scoring for conformation is that the animal is described rather than scored. To put a linear scoring system in place, breeding objectives for different traits and the two biological extremes on either side need to be defined very clearly. On a biological scale from 1 – 9 the population average lies at 5 (e.g back on the knee 1, forward at the knee 9, population average 5).

2.3.2.1 Linear scoring in the horse

Linear scoring in the horse was introduced later than in cattle and is still used only in some studbooks. The KWPN introduced linear scoring in 1989, describing 26 biological traits. Of these traits, 20 were conformation traits and 6 described movement at walk and trot. This studbook worked off a 40 point scale with the median 20 being described as the population average (Koenen et al., 1995). Three years later, in 1992, general traits for conformation and movement were added (de Groot et al., 2002).

The Italian Breeders Association of Haflinger Horses decided in 1989 – 1990 to revise its technical norms, its method of type classification and specified selection criteria. To classify for type they introduced the linear scoring system, to aid in selecting for a more distinct and better saddle horse. Additionally, the associations aim was to score traits individually rather than in combination and to objectively describe conformation. Estimation of breeding values could be based on a combination of the linear score of the animal itself and its relatives (Samore et al., 1997).

Similar to the above examples, the Dutch Shetland Pony Society introduced a linear evaluation system for type classification in 1989 to give an objective description of conformation, legs and movement. Van Bergen and van Arendonk (1993) used linear type data records from Shetland ponies and concluded that this data could be used to estimate breeding values for stallions.

Jakubec et al. (2007), in studies on linear description type traits in Old Kladrub horses, found variability in coefficients within traits of up to 40% in the forelimb. Furthermore, the study reported a wide use of the scale, with up to 7 to 9 scores out of a total of 9 used for most descriptive traits. This indicated a wide variability of conformation within the breed. The linear analysis in Old Kladrub horses was verified in 1995 for official use in evaluation.

In the thoroughbred sector, high importance is placed on conformational assessment, especially at sales. Mawdsley et al. (1996) recognised the importance of objective assessement and proposed a linear approach to assess conformation in thoroughbred horses. The study proposed 27 traits for the complementary evaluation in breeding selection. The study finally recommended 21 traits for effective evaluation as six traits proved to be unsatisfactory in their practical application.

A study in Irish Draught horses found that in a test trial where judges used both methods, the level of agreement was worryingly low in either scoring system, leaving the responsibility with the judge. In the study, assessor training was considered to be essential in achieving better results. Furthermore, it was noted that in order to implement a strategic breeding programme linear scoring, because of its descriptive nature, would be an advantage (Breen, 2009).

2.3.3 Conformation Traits

Judging conformation should be done bearing in mind what discipline or purpose the horse is used for. Desirable traits for one discipline may be undesirable for another, e.g. short stocky necks and upright shoulders are of advantage in carriage driving, whereas they would be a serious hindrance to a show jumper as bascule and good front leg technique would be compromised. Conformation refers to the whole horse; it should be evaluated not only at rest but when moving (Marks, 2000). Furthermore, the whole conformation of the horse is made up of individual traits. It is the description of these traits that make up the whole conformation of the horse and determine their function together as a whole.

2.3.3.1. Head and Neck

Ideally the head of a horse should be in proportion to its body (Oliver and Langrish, 1991, Anon, 1999). Facial features should be well defined and both authors agree that the head, and specifically facial expression, can reveal a lot about temperament.

Eyes should be bright, clear and alert. Brown eyes are preferred to wall-eyes as they are more sensitive to light. Small eyes are considered undesirable as they are usually set too far back and have thick eyelids, which affect vision and this may cause the horse to be nervous (Anon, 1999). Both wall-eyes and small eyes are seen as conformational faults and can impede the horse’s performance, especially during the cross-country course where simple fences are sometimes set under trees where lighting conditions suddenly change.

There are no conformational faults associated with the ears of a horse, they may be too big or small in proportion to the head but this is purely cosmetic. Literature only points out that horses with overactive, twitchy ears may indicate vision or hearing problems (Oliver and Langrish, 1991, Anon, 1999).

As horses can only breathe through their nostrils they should be large, open and thin walled to allow maximal air intake. This is very important for horses that are put under intense physical strain, such as eventing. Horses with small nostrils or dish faces, which restricts the nasal passage seen mainly in Arabian horses, may have reduced oxygen intake and are therefore limited in high intensity work over longer durations (Loving and Langrish, 1997, Anon, 1999) .

The head should be long enough to accommodate large, clear nasal passages and teeth. However, too long a head has been shown to be negatively associated with race times in 4 year old Standardbred trotters in Sweden, i.e. decreased speed (Thafvelin and Magnusson, 1985). This is further supported by other studies recognising that the head plays an important role in balancing the horse during locomotion. In order to elevate the hindquarters the horse uses its head as a weight on a lever and through an interaction between head size and weight, neck length and body length is able to do so effectively. Horses with small or big heads in comparison to their body size tend to be poor movers as they cannot properly counterbalance the heavier hindquarters (Anon, 1999). Beeman (1973) stated that an excessively large head adds unnecessary weight at the end of the balance arm (neck), particularly to a long slender neck.

A lot of room between the mandibles is preferred for the respiratory tract to operate more efficiently. Horses with narrow intermandibular space are thought to have a restricted upper airway due to recurrent laryngeal haemiplegia, also known as roaring or whistling, most commonly seen in thoroughbreds and standardbreds (Loving and Langrish, 1997). This prevents the horse from obtaining sufficient air to cope with cardiovascular demand, and therefore exercise at high speed such as the cross country phase of eventing become intolerable due to hastened muscle fatigue (Loving and Langrish, 1997). Weller et al. (2006b) support this contention with their study on National Hunt racehorses in which they demonstrated that a wider intermandibular width was associated to be of benefit in Jump Racing. The study found that an increase in intermandibular space was associated with an increase in life-time earnings, the number of races placed, an increase in the lateral coxal angle and an increase in the maximum British Horseracing Board Official Ratings.

The head-neck connection is considered of importance in riding horses as it can influence rideability, especially collection. Collection is the progressive development of carrying power in the hindquarters (McGreevy et al., 2005). It results in the transfer of weight from the front legs onto the hind legs of the horse in order to free up the forehand giving more freedom of movement in the forehand. In collection, the hindlegs will bend more in the stifle and hock joint and therefore step further underneath the horse's body in the direction of the centre of gravity. The horse will look and feel more "uphill" and the steps are getting shorter and higher, without losing activity or energy (German National Equestrian Federation, 1985).

The Dutch Warmblood Studbook in North America (2008) explains that a light connection is needed for acceptance of contact, good rideability and a soft mouth. Additionally they state that the FEI requires a 'supple poll as the highest point of the neck'. This connection is traditionally known as the throatlatch and describes the area on the underside of the neck where the head is attached. As previously outlined, this area should be light, and free of excess muscle or fat to aid lateral and longitudinal flexion at the poll (Anon, 1999). Flexion at the poll is important for acceptance of the bit and therefore important to achieve a good contact, which in turn is essential to achieve collection (Ross, 2003a). It allows the rider to ask for engagement of the hindquarters to come more underneath and carry more weight, this in turn will free up the fore hand and allow for movements such as extensions, counter canter and lateral movements required in eventing at advanced level (Tait, 1993, Eilberg and Newsum, 1993). Holmström (2001) found in a study comparing elite dressage and show jumping horses with 'normal' riding horses that elite horses had significantly greater throatlatch widths in comparison with ordinary riding horses.

A connection that is too light may cause overbending at the poll, and those horses tend to go behind the desired vertical and are said to be behind the bit, which is undesirable for achieving self-carriage (Loving and Langrish, 1997). Self-carriage is the horses self maintenance of rhythm, tempo, direction, straightness and outline in all three gaits (McGreevy et al., 2005). A horse with a thick throatlatch/head-neck connection may limit its air, food, blood and nerve supply when tucking in its head.

This may be due to large jowls or a fleshy, thick throatlatch and will hinder the neck from arching properly (Oliver and Langrish, 1991, Anon, 1999).

The neck of the horse should be well developed and muscled. Ideally it is in proportion to the body, generally making up about one third of the horse's length (Loving and Langrish, 1997). It acts as the balancing pole of conformation (Oliver and Langrish, 1991). Sufficient neck length ensures manoeuvrability, balance and good carriage. It should have some crest and the topline should flow smoothly into the withers and shoulder. The base should be set on to the body at the point of shoulder or higher (Anon, 1999). The Dutch Warmblood Studbook in North America (2008) specify further that a good length of neck is essential for going on the bit. Additionally it should be fairly long, slender and have an arched topline. The studbook further differentiates that show jumpers require a more horizontal position of the neck in order to achieve enough collection for take-off. Dressage horses, in contrast, need a more vertical position of the neck to achieve self carriage and a more uphill movement.

A short neck is said to affect flexibility of the neck and horses find it easier to resist to the aids and therefore a short neck can make for a strong ride (Oliver and Langrish, 1991). Furthermore, it is thought to contribute to a short choppy stride, which can cause difficulty to extended movements (Loving and Langrish, 1997, Anon, 1999).

Too long a neck is undesirable as it is much harder to develop in size and strength and is additionally associated with wobbler syndrome and laryngeal paralysis. Anderson et al. (2004) found in their study that with every 10 cm increase in the bottom of the neckline it was more likely for horses to experience effusion in the front fetlock. The authors believed the effusion in the fetlock may be due to the increased weight of the neck. From an equitation point of view, horses with long necks tend to have difficulties with straightness, which is essential for balance (Loving and Langrish, 1997).

Ewe necks and swan necks are faulty neck conformation and influence performance. Horses with these conformational faults tend to carry their heads too high and therefore find it hard to engage their backs causing these horses to hollow over the jump, or fail to work on the bit which negatively influences their performance in every phase of eventing (Tait, 1993, Loving and Langrish, 1997, Anon, 1999).

2.3.3.2 Shoulder and Withers

Shoulder

The shoulder provides the main area of attachment for the front legs to the rest of the body. A long shoulder provides a large area for muscular attachment resulting in better support and bigger range of motion, important in Sporthorse performance. In a review of literature Holmström (2001) highlighted the difficulty of assessing shoulder angle accurately with some studies using the angle between the scapula and humerus, others working from the horizontal plane to the line of the scapula and others even used the angle of the extended side. A further problem with shoulder angle is that it changes significantly with age which makes assessment in the immature horse difficult. A study following thoroughbred horses from weanling to 3 year old age found mean scapular spine angles of 54, 57, 58 and 60º in 0,1,2 and 3 year old horses respectively (Anderson and McIlwraith, 2004).

The length and slope of the shoulder may be directly related to stride length. Ross (2003a) report that horses with longer shoulders may have longer stride length and those with short shoulders a shorter stride length. There is a relationship between shoulder length and shoulder angle. Frequently horses with longer shoulders have smaller shoulder angles. A study on 4 year old Swedish Warmblood riding horses showed that a small inclination between the horizontal plane and the scapula positively affected scores given for walk and overall scores for gaits (Holmström and Philipsson, 1993). This argument is further strengthened with a study comparing elite horses with riding horses. Elite horses had a significantly smaller inclination of the scapulas compared to "normal" horses (Holmström et al., 1990). A further study investigating conformation and performance in 4 year old Standardbred trotters reported a positive regression of "earnings per start" on the angle of the shoulder joint (Thafvelin and Magnusson, 1985). Further investigation into why the shoulder angle plays an important role in selection of performance horses was offered by Beeman (1973) who stated that a long and sloping shoulder can provide sufficient space for a long humerus which is important for the proper positioning of the distal portion of the fore leg under the body in order to support the weight of the horse and provide for maximal shock absorption. In contrast to good conformation of this area, a straight shoulder predisposes to the horse's feet striking the ground more often and with more force over same distances. Therefore good shoulder and humerus conformation are expected to greatly reduce lameness, stress, strain and concussion. These findings are strongly supported by several other studies, one reporting that with an increased length of the humerus and a small angle of the scapula medical and orthopaedic status improved (Holmström and Philipsson, 1993). Similar findings were reported in a study in racing thoroughbreds where with every 10cm increase in scapular length there was a decreased likelihood of fractures to the carpus and the front limb by factors of 0.53 and 1.97 respectively, as long as pastern length remained constant (Anderson et al., 2004). Another study looked at the effect of and upright and short shoulder conformation in 4 year old Standardbred trotters and found that animals with these conformations presented more frequently with splints and synovial distention of the coffin joint and digital sheath (Magnusson and Thafvelin, 1985). Bad shoulder conformation also affects the rider's position, placing the saddle further forward and placing the rider in front of the centre of gravity rather than over, which increases the weight transferred onto the forehand (Dutch Warmblood Studbook in North America, 2008) decreasing the range of movement in the fore legs.

Wither

At maturity of the horse the wither should be level or slightly higher than the croup (Oliver and Langrish, 1991, Anon, 1999). Medium to high withers are said to be associated with long sloping shoulders, which is desirable for the full range of movement in the forelegs and allows for optimal foreleg extension.

Some studies have found a relationship between height of withers and length of distal bones in the horse. One study by Holmström and Philipsson (1993) found a significantly positive correlation between height at the wither and length of humerus. Another study following thoroughbred horses from weanling to 3 year old age found significant relationships between wither height at all ages and long bone length of the humerus, radius, third metacarpal and some hindleg bone lengths (Anderson and McIlwraith, 2004). Additionally they found a high correlation between wither height and croup heights which supports the theory that horses are in proportion in front and behind and that there is a proportional relationship between bone length and height at withers. Thafvelin and Magnusson (1985) in their study in Standardbred trotter found a significant positive regression in height at the withers and "Earnings per start" indication that taller wither heights are desirable for performance. This is in agreement with findings that elite dressage horses have higher wither heights than 'normal' horses

(Holmström and Philipsson, 1993). In essence taller horses were more favourable in this discipline.

From a longevity point of view, it is not advantageous to have very tall horses. It was shown in insured riding horses in Sweden that horses with recurrent lameness problems were taller. Similar findings were reported in Standardbred trotters, taller horses had more synovial distention of the hock joint and the coffin joint in the forelimb (Magnusson and Thafvelin, 1985).

For equitation purposes wither conformation has to be considered where range of movement and saddle fitting are concerned. A moderately high wither is desired for optimal engagement in collection and rounding the back over obstacles (Loving and Langrish, 1997). Withers that are too high predispose to saddle or blanket pressure and can even lead to fistulous withers (chronic inflammatory disease of the supraspinous bursa and associated tissues), all of which impede optimal performance (Dutch Warmblood Studbook in North America, 2008). Flat withers, also known as mutton withers, are usually associated with thick or loaded shoulders which obstruct freedom of movement in the forelimb (Loving and Langrish, 1997, Anon, 1999).

2.3.3.3 Forelimbs

Good limb conformation especially in the forelimb is important for lasting soundness in the athletic horse, as these bear 60-65% of the horse's weight (Adams, 1987). Clinical experience has revealed that disease in the locomotor system have been associated with faulty conformation in the extremities of horses (Stashak, 1987). Three-day event horses compete on extremely variable terrain and must be able to cope with all types of going and all types of gradients. Galloping and jumping across such terrain places huge strains on the limbs and back, and horses with poor limb conformation are particularly at risk to injury (Dyson, 2000, Bathe, 2003). A study carried out by Singer et al. (2008) revealed that of all injuries sustained by event horses 86% affected the limbs, and of those the forelimbs were more commonly injured with 66% in comparison to the hindlimbs. The most commonly injured part of the forelimbs in three-day events in this study was the metacarpal region. In a study on causes of death in insured French horses 20% of those were associated with locomotor disease (Leblond et al., 2000). As limb injuries usually require rest to recover they have a direct impact on the horses training and progression, highlighting the importance to prevent them.

Good limb conformation may reduce the risk to injury. Beeman (1973) states that the radius and ulna should be of sufficient length to allow for ideal muscle function, but the cannon bone should be short to have mechanical advantages. Additionally the carpus was identified as an important anatomical site in the limb, as a history of disease in the knees was found in broken down horses. The study highlights the importance of correct alignment of the carpal bones to allow for the whole structure to absorb concussion. The fetlock should have sufficient angulation for the tendons and ligaments to aid in weight support, concussion and propulsion (Beeman, 1973).

Knee

Back-at-the-knee or calf-kneed refers to a posterior deviation of the carpus, where the carpus is behind the plumb line (Adams, 1987, Ross, 2003a). In a study with thoroughbred yearlings it was found that a total of 6.6% exhibited back-at-the-knee conformation. This was found to have a negative association with racing performance in later life (Love et al., 2006). Another study looking at the development of conformation over time in thoroughbred horses found that the carpal conformation changed from weanling to 3 year old age: mean carpal angle of 176º (considered back-at-the-knee) changed to 181º (considered slightly over-the-knee) (Anderson and McIlwraith, 2004). A study in 108 thoroughbred horses (4 – 11 years of age) where limb conformation was measured in angles and lengths using markers showed that the majority of horses were back-at-the-knee to some degree (Weller et al., 2006a). Ross (2003a) found that back-at-the-knee conformation is very common and therefore acceptable in Standardbred pacers. Norwegian cold-blooded trotters were found to have a high prevalence of back-at-the-knee conformation with 36.8% (Dolvik and Klemetsdal, 1999). This conformational defect is reported to put strain on the inferior check ligament, the anterior aspect of the carpal bones, the volar annular ligament, the volar aspect of the joint capsule and chip fractures in the carpal bones commonly occur and small chip fractures in the radius (Adams, 1987). In a review of poor performance in sport horses, horses that are back-at-the-knee are not able to last in top level eventing and this conformation is regarded as a serious conformational defect in this field (Dyson, 2000, Bathe, 2003). Beeman (1973) considers this backward deviation of the knee the most serious defect of the front limb, and possibly the most serious in the entire horse.

The opposite of back-at-knee conformation is over-the-knee conformation or buck-kneed conformation. Over-the-knee conformation is an anterior deviation of the carpus caused by contraction of the carpal flexors, where the carpus is in front of the plumb line. Horses with this fault exhibit a tendency to buck forward, a knuckling of the fetlocks or are prone to stumbling (Adams, 1987, Ross, 2003a). This condition is often present at birth and in less severe cases it usually corrects by about 6 months of age (Adams, 1987). In young, untrained horses forward-on-the knee is thought to predict lameness. In older horses, especially cross-country horses, steeplechasers, jumpers and hunters, it is seen as an acquired characteristic of jumpers that exhibit the fault with no obvious lameness, according to Ross (2003a). Marks (2000) further specifies that slightly over the knee may protect against carpal disease in racehorses. In contrast to that a study in racing thoroughbred horses found that with every 1° increase in carpus angle, there is an increased risk of physeal enlargement and an increased risk of fracture in the proximal phalanx (Anderson et al., 2004). Comparisons of conformation of elite and non-elite Swedish Warmblood horses showed that 74% of elite jumping and dressage horses presented with over-the-knee conformation, whereas only 8% of riding school horses displayed this trait. Riding school horses presented with back-at-the-knee conformation more frequently (Holmström et al., 1990).

Bench-kneed, knock-kneed and bow legged conformation refers to a deviation at the knee level viewed from the anterior aspect. Bench-knee or offset at the knee is the lateral positioning of the metacarpals in relation to the central axis of the radius (Adams, 1987, Ross, 2003a). It has a 13% prevalence in Thoroughbred yearlings according to Love et al (2006). This type of conformation is associated with lameness as it puts greater stress on the medial splint bones causing splints, effusion in the fetlock, tendonitis and carpal fractures according to several different studies (Beeman, 1973, Ross, 2003a, Anderson et al., 2004, Weller et al., 2006b). Magnussen and Thafvelin (1985) report an increase in synovial disstention of the carpal joint in horses with bench knees but found no higher incidence in splints compared to horses without bench-knees. A study in Swedish Warmblood horses by Holmström et al (1990) found that offset knees did not interfere with performance. Knocked-kneed also referred to as carpus valgus describes a medial deviation of the carpal joints toward each other and is often accompanied by toe-out conformation. This concentrates the horses weight similar to a bench-kneed horse on the medial aspect of the carpus and the medial metacarpus, putting pressure on the joint capsule medially and all the ligaments located on the medial aspect of the carpus. This may cause splints as a result of the added pressure metacarpal II is under and striking of the opposing leg (Beeman, 1973, Adams, 1987, Ross, 2003a). A study in foals found that 39% of them displayed carpal valgus. There is a reduction of this fault as horses mature to yearling age. However carpal valgus at yearling age was associated with heavier bodyweights, suggesting load to be a contributing factor in inhibiting this natural correction (Santschi et al., 2006). Similar findings reported by Weller et al. (2006a) found that the average horse displayed some degree of carpus valgus and that in less severe cases it did not stop horses from pursuing a racing career, however the study suggests the condition may impair racing performance. Bow leg conformation, or carpus varus is the opposite of knock kneed conformation. The carpus is bowed outward from the radial plumb line. In severe cases it may be career limiting as it predisposes to osteoarthritis of the distal limb. Often this conformation is accompanied by toe-in (Adams, 1987, Ross, 2003a).

Tied in below the knee in a lateral view describes the appearance of the flexor tendon too close to metacarpal III just below the carpus. Usually the alignment of the flexor tendons and metacarpal III are parallel from the carpus to the fetlock. This conformation inhibits free movement and young horses with this conformation suffer from superficial flexor tendonitis (Adams, 1987, Ross, 2003a). This was confirmed in a study on 4 year old Standardbred trotters where tied in below the knee was related to swelling of the superficial flexor tendon (Magnusson and Thafvelin, 1985). An additional study on the same sample of horses showed that this trait had a negative effect on performance (Thafvelin and Magnusson, 1985). In a study in thoroughbred yearlings this fault was reported in 1.5% of the population (Love et al., 2006).

Distal Limb

Cannon bone circumference, width and length are attributed great importance in front leg conformation. Large circumference and width were associated with a higher occurrence of splints and synovial distention in the fetlock in Standardbred trotters (Magnusson and Thafvelin, 1985). Additionally, large circumference influenced racing performance negatively, however, other literature did not support these findings (Thafvelin and Magnusson, 1985). Both studies state large circumference and width of the cannon were strongly correlated with height at withers, larger horses had more bone substance. Loving and Langrish (1997) favour a short cannon, as weight of the distal limb is reduced and the pulley system of tendons and ligaments is favourable. A study in Swedish Warmblood horses showed that mares had shorter limbs and a smaller circumference of cannon bone compared to geldings and stallions (Holmström et al., 1990).

Common conformational faults in the pastern viewed laterally are short upright, long sloping and long upright pasterns. Short upright pasterns increase the effect of concussion in the fetlock joint, pastern joint and navicular bone. This type of conformation causes ring bone and navicular disease to develop (Adams, 1987). Bathe (2003) regards upright pasterns as one of the most serious conformational defects affecting soundness in the three day event horse.

Long upright pasterns are pasterns with an angulation over 45º to the foot and pasterns are too long in relation to limb length. Injury risk sites are similar to those in short upright pasterns with the exception of pastern joint. This type of conformational fault is commonly seen in thoroughbred horses and quarter horses (Adams, 1987). Weller et al. (2006b) found an increased risk of tendonitis of the superficial digital flexor tendon, which is usually associated with long sloping pasterns. Upright pasterns are seen as a significant ailment in jumping horses, however they are less common and significant in racehorses (Marks, 2000). Magnussen and Thafvelin (1985) support this with their study in Standardbred trotters, where with a more upright fetlock angle swelling of the superficial flexor tendon was observed.

Long sloping pastern, is an angulation of the pastern to the foot of 45º or under with pastern length too long for the length of limb. This type of fault is associated with injuries to the flexor tendons, the sesamoid bones and the suspensory ligament (Adams, 1987). Long sloping pasterns are frequently observed in thoroughbred race horses and are a common cause of breakdown (Marks, 2000). This belief is strengthened by a study carried out on racing thoroughbreds, where long pasterns increased the odds of front limb fractures (Anderson et al., 2004). Bathe (2003) believes that long sloping pasterns are a hindrance in three day eventing to some degree. In contrast to these studies, Holmström et al. (1990) found that elite dressage and showjumping horses had significantly longer pasterns than ordinary riding horses and lame horses, it is however important to note that there was no difference in the angulation of the pastern. In a study of conformation changes in thoroughbred juvenile horses long sloping pasterns in foals correct to a normal 45º angle at yearling to 2 year-old age and further developed to upright pastern angle at the 3 year-old age (Anderson and McIlwraith, 2004).

2.3.3.4 Hindlimbs

In general hindlimb conformational defects are less common and detrimental than in the forelimb as the centre of gravity and weight distribution are different to the front limb. The conformation of the femur in the sport horse is attributed high importance, as a long and forward sloping femur places the hindlimb more under the horse, which allows the horse to keep its balance more easily and carry more weight on the hindlimb. In studies in Swedish Warmblood horses those with more vertical femur conformation were more likely to have recurrent lameness and back problems (Holmström, 2001). Additionally Holmström et al. (1990) found that elite dressage and jumping horses had more forward sloping femur conformation than ordinary riding horses. However, in Standardbred trotters a long femur resulted in more synovial distention in the stifle joint (Magnusson and Thafvelin, 1985).

The gaskin, also known as the second thigh, lies between the hock and the stifle joints. Long gaskins correspond with longer muscles and longer muscles exert more pull, lengthening the stride and increasing the hindlegs action. The gaskin plays a role in the propulsion of the horse as it is responsible for the flexion and extension of the hindlimb, therefore providing power to run, jump and pull. Laterally viewed the wider the gaskin, the better the leverage (Anon, 1999).

Hock conformation viewed laterally should not be too straight or too angulated. Viewed from the side conformational faults of the hock are sickle hock conformation and straight hocks. Sickle-hocks describe an excessively angulated hock, whereby the hock angle is smaller than usual. This gives the leg an appearance of being camped under the horse from the hock down. Sickle-hocks are often described as “curby” hocks as this conformation often results in the development of curbs (inflammation of the plantar ligament), due to the increased stress put on the plantar ligament (Beeman, 1973, Adams, 1987, Anon, 1999, Ross, 2003a). Magnussen and Thafvelin (1985) confirm these findings with their study on Standardbred trotters as this abnormality in conformation was related to decreased orthopaedic status. Race horses with this abnormality, especially angles of less than 150º, are more prone to disease of the distal joints and curbs and may in extreme cases bruise the ergot region during exercise (Marks, 2000). Furthermore, this conformational fault was observed in Norwegian cold-blooded Trotters making this condition not specific to finer bred horses but also Cold-blooded animals where it was found that start status and earnings in horses with this abnormality were less than those without (Dolvik and Klemetsdal, 1999). Similar results were obtained by Holmström (2001) where horses with back and lameness problems had smaller hock angles than normal Swedish Warmblood horses. An earlier study carried out by this author comparing elite horses with non-elite horses showed that only one of the elite horses having sickle-hock conformation based on the population average, indicating that an absence of this trait is necessary to reach advance level (Holmström et al., 1990). In Icelandic horses the prevalence of sickle-hock conformation was found to cause an increased risk in degenerative joint disease (Axelsson et al., 2001) and bog spavin (swelling in the hock joint capsule) (Eksell et al., 1998).

Excessively straight hocks viewed laterally describe a leg that has a large angle in the stifle joint and a correspondingly large angle in the hock (Ross, 2003a). This conformational abnormality predisposes to bog spavin and upward fixation of the patella (Adams, 1987). Dyson and Bathe (2000, , 2003) both state that horses with straight hock conformation did not withstand the strain of top level eventing. This is confirmed by a study on the effects of the standing tarsal angel on joint kinematics and kinetics, which found horses with excessively large hock angulation showed less flexion, less energy absorption and had a limited propulsive ability (Gnagey et al., 2006).

Cow-hocked conformation, as viewed caudally, is when the distal part of the limb is rotated outward. As a result the hocks are closer together than the fetlocks usually this conformation is coupled with a toe out conformation. In excessive cases this conformational fault can lead to injury of the inside of the hocks and even bog spavin due to the interference of the legs with each other and the excess strain on the medial aspect of the hock (Adams, 1987, Anon, 1999, Ross, 2003a). A number of authors are of the opinion that cow-hocks in moderate form are of little concern as they only rarely cause lameness (Marks, 2000, Ross, 2003a). Thafvelin and Magnussen (1985) even found a positive effect of this trait on performance in Standardbred trotters. The authors observed an increase in earnings and number of starts in horses with this conformational fault. Additionally, a lower frequency of synovial distention in the hock was observed in the same horses (Magnusson and Thafvelin, 1985). However, another study in Norwegian cold-blooded trotters did not support this contention as this study found lower number of starts in horses with cow-hocks (Dolvik and Klemetsdal, 1999).

The opposite of cow hocks are bow-legs where the hock joints are too far apart and is usually coupled with base narrow and toe-in (Adams, 1987, Ross, 2003a). This type of conformation is uncommonly observed (Magnusson and Thafvelin, 1985, Adams, 1987, Ross, 2003a). Marks (2000) states this type of fault is not likely to withstand collection, as at speed of collection the hock moves more towards the centre line increasing stresses to the lateral surface.

2.3.3.5 Feet

Foot conformation in the horse is essential for effective shock absorption of the horse's weight and that of the rider at ground strike. The purpose of the hoof is to absorb concussion and prevent injury to other leg structures. Poor conformation of the foot will distribute the pressure unevenly resulting in lameness (Adams, 1987, Anon, 1999). The importance of the foot in the equine is highlighted by the commonly used saying "no foot, no horse" (Back, 2001b). The foot of the horse should be in proportion to body size and a generous size provides solid base and good shock absorption (Anon, 1999). Many hoof / foot imbalances are caused by poor limb conformation causing uneven loading / imbalance of the hoof (Curtis, 2000). A good quality foot should be thick enough to endure the horses weight without wearing the hoof excessively. Similarly the sole of the hoof should be thick enough to prevent bruising, the bars should be well developed and a large, strong frog is desirable (Adams, 1987).

Feet that are too large and wide are undesirable as they are prone to bruising of the sole, due to the lack of concavity of the sole. This conformation often results in a flat foot and is common in light bred horses (Adams, 1987, Anon, 1999). A problem with flat feet is they often present with thin soles that separate from the wall, causing laminar tearing (Parks, 2003).

Small foot conformation is another undesirable trait in hoof conformation as it is subjected to greater concussion. The area that the foot provides for shock absorption is too small and as a result navicular disease and ringbone are more frequent in horses with small feet (Adams, 1987, Anon, 1999). Thafvelin and Magnussen (1985) found a negative effect on earnings per start in horses with narrow feet.

Contracted and or high heels are usually a result of poor trimming, where the heels are left too long resulting eventually in contracting the heel. A problem of contracted heels is a loss of function in the frog as it is prevented from touching the ground by the high heel and therefore can no longer absorb shock (Adams, 1987, Pollitt, 1995, Anon, 1999). A study in Standardbred trotters found horses with narrow heels suffered more frequently from grease heels. The study deducted as a result of the impaired blood circulation, due to insufficient hoof expansion, there is an increased risk of grease heels (Magnusson and Thafvelin, 1985).

2.3.3.6 Back and Quarters

The back describes the region on the topline from the withers to the point of croup. It supports all structures associated with the thoracic and abdominal cavity, such as ribs, muscles and ligaments. The back needs to be a strong structure to support the weight of these structures and the additional weight of the rider A relatively short, straight and wider back make collection easier and is considered a stronger structure (Anon, 1999). A study on kinematic evaluation of the back in riding horses found that dressage horses had significantly longer lumbar backs than jumping horses by almost 5 cm (Johnston et al., 2004).

Conformational faults of the back include an excessively long or short back, sway back and roach back conformations. A long back can be of advantage in some sports such as dressage, as it is relatively supple. However, a longer back makes collection harder and is more prone to muscular and ligament strain (Jeffcott, 1999). Commonly, horses with long backs have long loins and this creates a weak back, which usually sags under stress and makes lateral movements difficult (Anon, 1999).

A short back is associated with rigidity through the spine and this lack of flexibility can cause a short choppy stride (Anon, 1999, Jeffcott, 1999). Jeffcot (1999) observed an overriding of the dorsal spinous processes (“kissing spines”) more frequently in thoroughbred geldings with short backs. An additional problem observed in horses with short backs is a higher likelihood of the hindlegs interfering with the front legs. Over-reaches and scalping are also more frequently observed in such animals (Magnusson and Thafvelin, 1985, Holmström, 2001, Ross, 2003a). However, the above authors agree that a short back is stronger and longer lasting than a long back and Magnussen and Thafvelin (1985) found Standardbred trotters with short backs had fewer problems with back pain than horses with long backs.

Horses with a sway back have an unnatural sunken dip between wither and loin, this stresses the back ligaments, which weaken and sag. This conformational abnormality can sometimes be caused by increasing age, pregnancy and nutrient deficiency (Anon, 1999). Mawdsley et al (1996) observed a sunken back more frequently in stallions and attributed this to the increased age of this type of animal.

Roach back conformation is a concave arching of the spinal column in the loin region. This limits the range of movement in this area especially for lateral movements and collection (Anon, 1999).

The hindquarters are the "power house" of the horse, making it possible for the horse to propel itself forward at speed, upwards over fences and in dressage horses carry more weight on the hindlegs (Holmström, 2001). The croup, pelvis and thigh make up the hindquarters and provide the area of attachment for the powerful, large muscle layers of the hindquarters. The croup length is the distance from the point of hip to the point of buttock and a long croup provides the muscles of the quarters with more power and leverage. Flatter croups are preferred to as steep croups, they result in a longer more ground-covering stride length (Anon, 1999, Ross, 2003a). This is reflected in a study by Holmström (2001) where elite dressage and jumping horses had significantly flatter pelvises than 'normal' riding horses.

In contrast a severely angled croup is a steep croup, or sometimes referred to as goose-rumped (Anon, 1999). In Standardbred trotters a steep croup was associated with synovial distention of the hip joint and stifle joint, and some irregularities in the hock and fetlock joint, suggesting that this type of conformation is not favourable (Magnusson and Thafvelin, 1985). Mawdsley et al (1996) in a study on conformation in thoroughbred horses found shorter croup lengths in stallions, but attributed these findings to selecting mainly stallions bred for sprinting as shorter croups make for shorter stride length. The author suggested that with an inclusion of stayers the result might have been different.

Viewed caudally the quarters should be symmetrical, where this is not the case muscle atrophy or a fracture of the tuber coxae may be present. Fractures in this area are often caused by trauma, such as a fall, but can also be stress related athletic injuries

(Pilsworth, 2003). Horse falls were the second most common cause of injury in a study on injuries in event horses accounting for 19% of injury causes. The most frequent injury cause was hitting a cross country fence (Singer et al., 2008). Additionally Standardbred trotters with an asymmetry in the quarters were reported to have difficulties performing at speed and as a result had significantly lower earning, lower number of races and poorer racing records (Magnusson and Thafvelin, 1985).

2.3.3.7 Structure

The structure of the horse is often referred to as the frame, it describes the relationship between height at wither and length from point of shoulder to point of buttocks. In traditional draft horses, such as the Noriker, this relationship is equal and therefore such horses are referred to as quadratic or square (Druml et al., 2007). Similar to the short back, this is a strong structure as draught horses were bred especially for their durable attributes. A study by Mueller and Schwark (1979) found that horses competing in show jumping, dressage and three-day eventing are squarer in structure. A ratio equal or slightly longer in length than in height is preferred by Ross (2003a) , which agrees with more recent literature. The trend to a longer or more rectangular shape seems to be of advantage in performance and studbooks such as the Dutch Warmblood, Hannovarian and Swedish Warmblood selected for this (Holmström et al., 1990, Christmann, 2007, KWPN, 2009). Weller et al. (2006a) found in a sample of National Hunt racehorses that wither height was shorter than body length, which follows the trends desired in Sporthorse breeding.

2.3.3.8 Gaits

One of the main indicators of the future level of performance of a horse is the horse's gait. The gait is a complex, co-ordinated rhythmic and automatic movement of the limbs and the whole body of the horse, which results in the progressive movement of the horse (Barrey, 1999). Introduction of an objective method of evaluating gait at an early age as an indicator of performance would benefit every equestrian discipline and avoid investing resources on horses that will not succeed at a desired performance level. At pre-purchase examinations and studbook selections, movement is routinely assessed (Back, 2001a). In a study on breeding objectives for Warmblood Sporthorses 14 out of

19 studbooks included gait as one of their breeding objectives and all but one of these gave it a high weighting of importance within their objectives (Koenen et al., 2004).

Walk

The walk is a four beat gait, every beat is a ground strike of a foot and each foot hits the ground independently. It is the slowest equine gait and there is no period of suspension; a period where no foot touches the ground (Barrey, 2001, Ross, 2003b). When horses are assessed at auction or studbook inspections, often only the walk is assessed for practical reasons. Among judges it is commonly thought that the walk gives a strong indication of the canter. Holmström and Philipsson (1993) found a correlation between the two gaits, however, the authors stated that the correlation was not large enough to solely use the walk as an effective indicator for the canter. At Dutch Warmblood stallion performance tests the walk is scored primarily on purity, clear 4 time beat, correctness of the movement, suppleness and length of stride (Huizinga et al., 1991a). Another study in Dutch Warmblood horses found genetic correlations between the walk and trot and performance in dressage, however the study found that correctness at the walk had no linear relationship to performance (Ducro et al., 2007a). This suggests that although the walk is an important gait for dressage, deviations at walk will not impede performance. Common deviations at walk are related to toe in and toe out conformation of the forelimb. Toe-out conformation is very prevalent in certain breeds, such as the Standardbred trotter, where it is suggested to be normal conformation based on its high prevalence and positive effects on the number of starts (Thafvelin and Magnusson, 1985). In a sample of thoroughbred yearlings this trait was the most prevalent in a conformation study, as a total of 30.1% of all yearlings displayed this trait (Love et al., 2006). This type of abnormality affects the flight path of the foot, where the feet wing to the inside as viewed cranially. This may cause the horse to interfere with the opposite limb or causing plaiting, a distinct placement of one foot directly in front of the other on the same line. Toe in conformation will cause the limbs and feet to wing out, dish or paddle, which is an outward deviation of the foot during flight. This may predispose to interference with the hindlimb on the same side and can cause damage to the medial sesamoid through interference (Adams, 1987, Ross, 2003a). Horses with either toe in or toe out conformation of a severe nature were found to have lower mean and average lifetime British Horseracing Board ratings (Love et al., 2006).

Trot

The trot is a two beat gait with a phase of suspension. It is a diagonal gait, whereby the diagonal pairs of limbs move simultaneously (Barrey, 2001, Ross, 2003b). In the trot there is an increased forward velocity due to a greater impulse from the hindlimbs (Back, 2001a). For the trot to be considered of good quality, it should have a slow stride frequency including a long swing phase. Additionally a good engagement is required, where the hindlimb is placed as far as possible underneath the body in order to achieve maximum propulsion (Barrey, 2001). The description of the desired trot for the selection of Dutch Warmblood jumping and dressage horses suggests that the trot should be pure, light-footed, two-beat with activity, suppleness, push, balance and self carriage (KWPN, 2009).

Canter and Gallop

Canter and gallop may be considered as the same gait performed at different speeds. The canter is a three beat and the gallop is a four beat gait, at the slower speed of the canter the diagonal pair of legs fall synchronised, while at the gallop the leading hindlimb touches the ground before the non leading forelimb. The leading leg in the canter and gallop is the front leg that lands last in a stride sequence. Horses usually choose the left foreleg in a left turn and the right foreleg in a right turn (Barrey, 2001, Ross, 2003b). Stride length and stride frequency are inversely related, the longer the stride the lower the frequency (Back, 2001a). Success in the cross country phase of eventing is dependent on a long stride. This was demonstrated at the Seoul Olympics, where horses with longer strides and faster speed in the steeplechase phase ranked higher (Deuel and Park, 1993). With the elimination of the steeplechase phase this may have changed, however cross country times are still very fast in the new format of eventing. At CCI4* (Concours Complet International – International Three-day event at the highest level) Badminton Horse Trials 2009 a total of 73% of the horses that finished the trial completed the cross country section within the allotted time (Badminton Horse Trials, 2009).

2.3.4 Heritability of Conformation

Conformation is an important factor in horse breeding and selection. As it is believed that conformation is associated with performance and durability, it becomes a very important criterion for selection of warmblood and thoroughbred horses alike. Poor conformation is considered to take away considerably from the value of a horse at sale. Conformation evaluation from an early age is a well recognised and established method to assess if a horse is suitable for a purpose and the horse's value (Preisinger et al., 1991, Love et al., 2006).

Several studies on different breeds of horses have looked at the heritability aspect of conformation (Koenen et al., 1995, Samore et al., 1997, Stock and Distl, 2006, Albertsdóttir et al., 2007, Druml et al., 2007, Thorén Hellsten et al., 2009). A number of studies were carried out to investigate heritability under different breed objectives and individual scoring systems and measurements, which makes it somewhat difficult to compare. One study in a Trakehner horse population, scored on a traditional scoring system (refer to 1.3.2), reported heritabilities for overall conformation to be 0.18 in foals and 0.17 in mares (Preisinger et al., 1991). Several other heritability and genetic correlation studies looked at conformation in a linear scored system (refer to 1.3.3) with each conformation trait examined separately.

In Table 1 a summary of heritability values are displayed from a number of studies, traits for all studies were measured on a 0-10 point scale, with the exception of Koenen et al (1995), who evaluated a 0-40 point scale with similar results.

Table 1: Heritability of Different Conformation Traits

Conformation Trait	**Heritability**
Type	0.28 – 0.38
Head	0.11- 0.49
Head-Neck Connection	0.21 – 0.24
Neck Traits	0.04 – 0.31
Saddle Area (whither and shoulder)	0.05 – 0.39
Whither Height	0.20 – 0.67
Front Leg Traits	0.08 – 0.2
Hind Leg Traits	0.1 – 0.23
Back and Hindquarter	0.15 – 0.29
General Impression / Frame/ Structure	0.19 – 0.37
Walk	0.12 – 0.26
Trot	0.20 – 0.38

(Source: Koenen et al., 1995, Samore et al., 1997, Stock and Distl, 2006, Albertsdóttir et al., 2007, Druml et al., 2007, Thorén Hellsten et al., 2009)

Studies on heritability of defects tend to centre round faulty conformation of the limbs. The inheritance of conformational defects may be linked to a decrease in performance or a predisposition to lameness. Ross (2003a) has stated that early conformational defects seen in foals are often present in dams and has suggested that the dams contribute more to faulty conformation. This may be attributed to mares not having to go through the same selection procedures as sires, sometimes not having to be evaluated at all to be part of a studbook. Heritability estimates for conformational defects range from 0 – 1, with Dolvik and Klementsdal (1999) reporting the highest estimate in the front limb for calf knees at 0.42 with all other front leg traits having lower estimates in a sample of Norwegian Cold-blooded trotters. In the hind limbs, the same study reported heritability estimates of 0.65 for straight hocks and lower estimates for all other remaining traits. A study on thoroughbred yearlings revealed higher heritability estimates with 1.0 for tied in below the knee and the lowest estimate of 0.16 for base narrow and turned out feet (Love et al., 2006). In the study by Love et al., (2006) the heritability of back at the knee/calf knees had an even higher heritability of 0.66. Many of the defects mentioned are associated, to some degree, with lameness. Lameness, as one of the greatest contributor to loss in revenue in sport horses, is reported to have heritability estimates of 0.25 and 0.33 in a population of standard bred trotters, with almost 70% of the study’s population being affected by lameness (Dolvik and Gaustad, 1996).

2.4 Genetic Analysis of Performance Traits

Breeding performance horses is the aim of every warmblood studbook. At studbook selection, conformation and performance are tested in order to get an idea of the quality of performance horses produced (Koenen and Aldridge, 2002). Several studies have used data from performance tests to estimate heritability of performance in order to indicate future success early and shorten generation intervals (Huizinga and van der Meij, 1989, Thorén Hellsten et al., 2006).

The estimates of heritability of gaits vary across different study populations and the type of scoring environments used to estimate these values. In a sample of Dutch Warmblood mares heritability of gaits in the walk, trot and canter were 0.22, 0.14 and

0.18 respectively (Huizinga et al., 1990). At stationary performance tests of Dutch Warmblood stallions higher heritability estimates were found for all gaits, for walk the estimate was 0.73, for trot 0.65 and for canter 0.54 (Huizinga et al., 1991b). In both studies relatively high genetic correlations were found between gaits. Walk to trot and walk to canter had genetic correlations of 0.62 and 0.67 respectively, however the genetic correlations between trot and canter was slightly lower with 0.44 in the mare study (Huizinga et al., 1990). The stallion study yielded higher genetic correlation values probably due to the difference in testing methods, as mares were assessed at field performance tests and stallions at stationary performance tests. The highest genetic correlation of gaits was found between trot and canter with a value of 0.93, a similar value of 0.92 between walk and trot and a slighter lower genetic correlation of 0.88 was found between walk and canter (Huizinga et al., 1991b). Heritability estimates in Swedish Warmblood stallions for gaits were 0.46 for walk, 0.37 for trot and 0.39 for canter. The strongest positive genetic correlation was found between trot and canter with a value of 0.71, walk to trot and walk to canter had a genetic correlation of 0.40 (Gerber Olsson et al., 2000). Ducro et al. (2007a) used linear scoring data for their analysis of heritability in Dutch warmblood horses. The heritability scores of walk included correctness, stride length and elasticity and heritability estimates for these ranged from 0.15 – 0.25. Trot descriptions used for analysis included stride length, elasticity, impulsion and carriage, heritability estimates for these traits ranged from 0.28 to 0.32. The canter traits assessed were the same as for trot with the exception of elasticity, the values estimated for heritability ranged from 0.19 – 0.25. The scores for walk and trot were genetically correlated with an overall score for movement and all traits were strongly genetically correlated with movement, with the exception of correctness of the walk. The strongest genetic correlation was found between all traits describing the trot and movement 0.93 – 0.97. Another study in Dutch Warmblood stallions yielded similar results with heritability estimates of walk, trot and canter ranging from 0.25 – 0.50, the lowest heritability was estimated for the canter. High positive genetic correlations were estimated for relationship between gaits, ranging from the highest between walk and trot 0.86 to lower correlations for walk to canter and trot to canter 0.70 and 0.75 (Ducro et al., 2007b). These studies all demonstrated the strong genetic correlation between gaits and these findings strengthen the common believe that judging the walk and trot is sufficient to indicate ability at the canter.

In order to select young horses based on genetically estimated parameters, several studies were carried out testing the genetic correlation between gaits and performance results in showjumping and dressage. Huizinga et al. (1990) found that there was a very low genetic correlation between trot and jumping ability 0.07. There was a slightly higher genetic correlation between walk and jumping ability of 0.34 and the highest correlation was found between the canter and jumping ability at 0.67 in a sample of Dutch Warmblood mares. Similar findings were reported in a study in Swedish Warmblood horses where high genetic correlations were found between gaits and competition performance in dressage, ranging from 0.63 – 0.75. Specifically, the canter showed high genetic correlations with both dressage and showjumping performance (Wallin et al., 2003). The jumping stride is an amended gallop stride with an extended airborne phase in the push off from the leading hindleg to the landing of the diagonal frontlimb (trailing forelimb) (Barrey, 2001). For this reason a close relationship between the canter and jumping can be expected depending on the scoring methods applied. However, in a sample of Dutch Warmblood stallions genetic correlations between the three basic gaits and showjumping were relatively low with values from 0.10 – 0.22, even lower for free jumping performance with values from 0.05 – 0.13 and slightly higher with cross country performance with values ranging from 0.28 – 0.31 (Huizinga et al., 1991b). Similar findings were reported by Gerber Olsson et al. (2000) who reported genetic correlation values of Swedish Warmblood horses between walk, trot and canter and loose jumping of 0.14, 0.22 and 0.31 respectively. Similar trends were found for all three gaits and jumping under the rider. Additionally a study with competition in later life of Swedish Warmblood horses found a high correlation between gaits and jumping performance and dressage (Olsson et al., 2008). In a more recent study in Dutch Warmblood horses descriptive linear traits of walk and trot showed a very low genetic correlation to jumping near zero, but canter traits showed a moderate relationship to jumping performance. All of gait traits, except for correctness of the walk, had a positive correlation with dressage with values between 0.40 – 0.67 (Ducro et al., 2007a).

Heritability estimates of jumping ability in competition in a sample of French pony breeds ranged from 0.20 – 0.30 (Anne, 2004). Free or loose jumping traits at stationary and field performance test were highly genetically correlated with jumping performance under the rider in Swedish, Dutch and German Warmblood horses, with values ranging from 0.57 – 0.93 (Schwark et al., 1988, Huizinga et al., 1991b, Gerber Olsson et al., 2000, Wallin et al., 2003, Olsson et al., 2008). Huizinga et al (1991b) found a relatively high genetic correlation between jumping and cross country performance with a value of 0.72, indicating that the two are closely related and one may give an indication of performance in the other in Dutch Warmblood horses. Interestingly, in a study in German Warmblood horses where performance data of the offspring of specific dressage and showjumping stallions were analysed, it showed that dressage stallions have a significant negative effect on jumping performance in their offspring when mated with jumping mares, -0.43. However, the riding horse points and scores for leg traits are favourably affected (0.48 and 0.40) by this mating. Another finding of this study was that jumping sires positively influence jumping and dressage ability of their offspring, even when mated with mares that have higher dressage abilities, making these stallions ideal for production of all-round horses (von Lengerken and Schwark, 2002). In a study of event horses in Britain, heritability was estimated for each discipline and they were all significantly above zero. However heritability estimates were low with dressage performance heritability ranging from 0.09 – 0.11, showjumping ranging from 0.08 – 0.23 and cross country ranging from 0.02 - 0.03 (Kearsley et al., 2008).

Several studies on genetic inheritance of performance in horses looked at effect of age. Such studies compared data from horses in young horse competitions and higher grade competitions of older horses. A variety of studies, across a variety of Warmblood breeds, found high genetic correlations, 0.64 - 1.00, between low level competitions such as pre-novice, novice, 3-year old, 4-year old, 5-year old, 6-year old classes all designed for young horses and intermediate and advanced level competitions (Huizinga and van der Meij, 1989, Aldridge et al., 2000, Viklund et al., 2005, Wikström et al., 2005). Similar results were found in a number of studies in event horses where heritability coefficients ranged from 0.20 – 1 (Ricard and Chanu, 2001, Kearsley et al., 2006, Kearsley et al., 2008). More specifically when these studies compared pre-novice level competition with advance level competition genetic correlation ranged from 0.30 – 0.99. This indicates that horses with good performance at a young age are more likely to be successful in later life, making young horse competitions extremely useful for early identification of future performance horses.

Chapter Three

Research Methodology

Chapter 3: Research Methodology

3.1 Research Objectives

One objective of this study was to evaluate selection methods for young event horses in Ireland. Currently in Ireland, selection of young event horse is not carried out by any of the studbooks. The Future Event Horse League (FEHL) provides a base for owners to start careers of young event horses. The league is run in a different format to eventing, and as part of the competitions, judges score the potential of the horse for this particular sport. Data from competitions of FEHL were analysed in order to evaluate conformation and suitability of the horses that participated and the consistency of scoring in the competition.

Another objective was to evaluate conformation in young event horses. Conformation evaluation was carried out, to provide an overview of the conformation of horses produced for eventing in Ireland. For this purpose 2 years of conformation evaluation on horses competing in the FEHL was conducted by the author.

A final objective was to determine the type of horse suitable for eventing at elite level. Since the new format of eventing was introduced opinions on the type of horse suitable for the sport are divided. Traditionally a predominantly thoroughbred horse was preferred to cope with the long format of competition. With the change in competition, requirements on conformation may have changed. For these reasons, interviews with riders competing at Four Star level were carried out.

3.2 Assessment of Horses in the Future Event Horse League

The Future Event Horse League (FEHL) describes its objectives to identify, produce and promote Irish-bred horses for eventing, by providing a league for 4 and 5 year old horses (Future Event Horse League, 2009). The league consists of a series of nine qualifiers run from June to September in different locations around Ireland leading up to the final in September held at Tattersalls. The qualifiers, up to August, also qualify 40 horses to compete at the Royal Dublin Horse Show. The league qualifiers and final consists of three phases; the Ridden Display of Basic Flatwork (RD), the Jumping phase

(J) and the Suitability and Potential (S&P). In order to qualify for the final, horses need to complete at least three qualifiers and achieve minimum average scores of 60% in Ridden Display of Flatwork and in Suitability and Potential. Additionally a maximum of 16 penalty points in the jumping phase is tolerated.

In Table 2 the number of horses over the years included in this study are displayed. It is important to note that only horses that completed at least two qualifiers or more, were included in the sample set. Average scores from all qualifiers a horse attended for each phase were used, in order to minimise judge, event, condition and weather biases. Six year old horses competed for the last time in 2004, due to this and the small number, this age category was excluded from further analysis.

Table 2: Number of Horses scored in the FEHL from 2004 – 2009

Year	**Number of Horses**	**4 year olds**	**5 year olds**	**6 year olds**
2004	97	41	44	12
2005	107	69	38	-
2006	138	69	69	-
2007	145	77	68	-
2008	111	66	45	-
2009	127	77	50	-
Total	**725**	**399**	**314**	**12**

3.2.1 Ridden Display of Basic Flatwork

The Ridden Display of Basic Flatwork (RD) is a basic ridden test similar to a dressage test in a 60 x 20 m arena with the emphasis on the natural ability of the horse under a rider. This phase is scored by a judge according to execution of the required movements, the quality of the horse's basic paces, its aptitude for work and the correctness of the foundation of training (Future Event Horse League, 2009). The correctness of training foundations is in equestrian terms the education of the horse in line with the scales of training. These principles are used by almost every formal equitation school in the world, and were formally developed by the German National Equestrian Federation. Experienced dressage judges are selected by organisers of the qualifier and the test is scored on criteria set out by FEHL. An example of the score sheet used for this phase is shown in Figure 2 & 3. The test for 4 year old horses (Figure 2) is different to the 5 year old test (Figure 3) and judges score every movement as set out by the score sheet. The main differences are because 5 year old horses more advanced in their training they are expected to show some lateral movements and show some work in 15 m circles (Figure 3). The total score possible is 130 and the score achieved is expressed as a percent. Similar to a dressage test, the higher the score the better. Final scores for this phase were available for all years, without the breakdown of the prescribed movements.

FLAT WORK DISPLAY **4 YEAR OLDS**

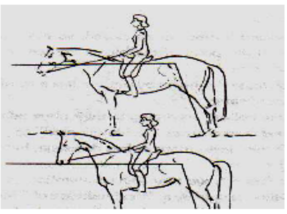
20m X 60m Arena. No collected movements. All trot work rising
Tack: As per current FEHL Rules. Spurs permitted NO Whips

Objective: To interpret from a series of simple, prescribed movements, the quality of the horse's basic paces, his aptitude for work and the correctness of his foundation training which might, in time, complement the achievement of his full potential

		Prescribed Movements	Max Marks	Judges Marks	Observations
1	A C	Enter at working trot and proceed down the centre line without halting. Track Left	10		
2	HXF A	Change the rein, working trot Medium walk	10		
3	KR RMC	Change the rein, free walk on a loose rein Medium walk	10		
4	C E EVKA	Working trot Circle left 20m diameter Working trot	10		
5	A FS S	Medium walk Change the rein, free walk on a loose rein Medium walk	10		
6	H C	Working trot Circle right 20 m diameter Between M and centre line working canter right	10		
7	CMBF F	Working canter Working trot	10		
8	KXM	Change rein showing a few lengthened strides	10		
9	M C CHE	Working trot Circle left 20 m diameter Between H and centre line working canter left Working canter	10		
10	E V	Working trot Circle left 20m and allow the horse to take rein and stretch neck Before V re-take the reins	10		
11	A X	Down centre line Medium Walk	10		
12	I	Halt. Salute	10		
		Leave arena on a long rein	NIL		
13		Rider's tact, effect and accuracy	10		
		Total	**130**		

Errors over the course are penalised:
1st Error of course……………- 4
2nd error of course…………- 8 (cumulative)
3rd error of course…………Elimination

Total of column 2
Total penalty marks to deduct



4 Year Old Outline Total marks

5 Year Old Outline Judge's Signature: ____________________

Figure 2: Example of Ridden Display of Basic Flatwork Score Sheet for 4 Year Old Horses in the Future Event Horse League

FLAT WORK DISPLAY **5 YEAR OLDS**

20m X 60m Arena. No Collection (overbending). Rising or sitting trot
Tack: As per current FEHL Rules. Spurs allowed. No whips.

Objective: To interpret from a series of simple, prescribed movements, the quality of the horse's basic paces, his aptitude for work . and the correctness of his foundation training which might, in time, complement the achievement of his full potential

	Prescribed Movements		Max Marks	Judges Marks	Observations
1	A C	Enter at working trot and proceed down centre line without halting Track right	10		
2	B BPFA	15m circle right in working trot Working trot	10		
3	A L	Down centre line Leg yielding to H	10		
4	C MV VK	Medium walk Change rein. Free walk on a loose rein. Medium Walk	10		
5	A B BRMC	Working trot Circle left 15m diameter Working trot	10		
6	C I	Down centre line Leg Yielding to K	10		
7	A FXH	Commence 20m diameter circle left Transition to working canter left between A and F Change rein with a transition to trot over X	10		
8	Between H and C C MBF	 Working Canter right 20 m circle right, give and retake reins over centre line Working Canter	10		
9	F KXM M	Working trot Progressively show lengthened strides Working trot	10		
10	C	Circle left 20m diameter and allow the horse to take rein and stretch neck Before C re-take the reins	10		
11	CHSE E I	Working trot Half 10m circle left to X Medium Walk	10		
12	G	Halt. Salute	10		
		Leave arena on a long rein	NIL		
13		Rider's tact, effect and accuracy	10		
		Total	**130**		

Errors over the course are penalised:
1st Error of course……………- 4
2nd error of course…………- 8 (cumulative)
3rd error of course……………Elimination

Total of column 2
Total penalty marks to deduct

4 Year Old Outline

Total marks

5 Year Old Outline

Judge's Signature: ____________________

Figure 3: Example of Ridden Display of Basic Flatwork Score Sheet for 5 Year Old Horses in the Future Event Horse League

3.2.2 Suitability and Potential

In the FEHL the animal's suitability and potential as a future international event horse, is assessed throughout all phases of competition. It is judged by experienced judges according to set criteria and these judges change at every venue and different judges assess each of the phases. Suitability and Potential is assessed during the Ridden Display Phase, the Jumping Phase and horses are also presented in-hand at a triangle (20m x 30m x 20m) for the Presentation and Trot-Up.

The suitability and potential of the Ridden Display of Basic Flatwork was introduced in 2006 and therefore was not available for the previous years. When originally introduced in 2006 it only consisted of Type/Model and Quality of Movement, thereafter more variables were added to the score sheet and the Type/Model variable was moved to the Presentation and Trot-Up score sheet. In order to include the 2006 scores and use the same variables, the Type/Model scores of the Presentation and Trot-Up in 2007, 2008 and 2009 were added to the average score achieved for Quality of Movement of the suitability and potential of the Ridden Display of Basic Flatwork score sheet (Figure 4). The quality of movement was determined by adding up the quality of walk, the quality of trot and quality of canter and calculating the average. For analyses of the data, the following variables were included:

Ridden Display of Flatwork (2006 – 2009) Total possible score: 20

- Type / Model 10
- Quality of Movement (under saddle) 10

In the Presentation and Trot-up phase the score for presentation was omitted as it is a score for the skill of the rider and does not reflect on suitability of the horse. Furthermore the score sheet for this phase changed over the years and did not include a Type / Model score in 2004 and 2005, therefore it was omitted from analyses of this phase. An example of a score sheet used since 2006 is shown in figure 3. This resulted in the inclusion of the following variables:

Presentation and Trot-up (2004 – 2009) Total possible score: 20

- Conformation 10
- Movement (walk and trot in-hand) 10

Data for suitability and potential of jumping were available in the same format for all years. The following variables were included for the suitability and potential of Jumping:

Jumping (2004 – 2009) Total possible score: 50

- Movement Canter and Gallop 10
- Jumping Capacity and Technique 10
- Temperament/Rideability 10
- Rhythm/Fluency 10
- "Star Quality" 10

10. Excellent	5. Sufficient
9. Very Good	4. Insufficient
8. Good	3. Fairly bad
7. Fairly good	2. Bad
6. Satisfactory	1. Very bad

Future Event Horse League 2008

Criteria and maximum points for judging
SUITABILITY AND POTENTIAL (S&P)
as a future international event horse

Ridden Display of Basic Flatwork

1. Relaxation		10
2. Rhythm		10
3. Acceptance of Contact		10
4. Natural Outline		10
5. Quality of Walk		10
6. Quality of Trot		10
7. Quality of Canter		10
8. Straightness and Balance		10
9. Attitude to Work	*4-year olds*	10
9. Engagement of Quarters	*5-year olds*	10
TOTAL		90

Presentation and Trot-Up

1. Type – Model		10
2. Conformation		10
3. Movement	*Walk and Trot in hand*	10
4. Presentation	*Skill of Rider*	10
TOTAL		40

Jumping

1. Movement	10
2. Jumping	10
3. Temperament/Rideability	10
4. Rhythm/Fluency	10
5. "Star Quality"	10
TOTAL	50

Figure 4: Suitability and Potential Score Sheets for all phases

3.2.3 Jumping Phase

The jumping phase is run over a derby type course in an enclosed arena with a mixture of cross-country fences and knockable poles; it may also include combination fences. All horses started with the same score of 144 and depending on knocked poles, refusals and time faults lose points off their maximum score. For refusals, 8 points are deducted and for knocking of poles 4 points deducted. Horses which are over the allotted time also incur a deduction of points. As only final scores were available with no information on refusals, knocked poles and time faults, scores for this phase were not included for analysis.

3.3 Conformation Analysis

Conformation analysis was carried out by the author on 422 horses. This included horses that participated in the FEHL in 2007 (150 horses) and 2008 (191 horses), thoroughbred horses at the Derby Sale (23 horses) at Tattersalls Ireland on the 25th of June 2008 and Sporthorses at the Performance Horse Sale in Goresbridge (58 horses) on the 11th, 12th and 13th of September 2008.

In response to interviews carried out with elite event riders the two auctions / sales were included in order to get a more representative sample of horses suitable for eventing (refer to section 2.4). Riders indicated horses for the sport were bought at Performance Sport horse and thoroughbred auctions. All 4 and 5 year old horses were marked in the relevant sales catalogues and lot numbers of these horses were randomly selected in order to get a representative sample of the sale in the timeframe available. Vendors were approached at the sales and asked to stand, walk and trot the horse in-hand in order to assess their conformation and movement.

Conformation assessment, of horses that were part of the Future Event Horse League qualifiers, was carried out during the Presentation and Trot-Up Phase. The horses were presented in-hand at the triangle with only a bridle and stood at A to assess conformation by the FEHL judge and the author independently. During this time a picture was taken for future reference to ensure numbers on sheets and names matched the horses presented. Handlers led horses around the triangle (A → B → C → A) in walk to assess movement from behind, side-on and front on view, the same procedure was then utilised the trot. To finish, horses were stood up at position A (Figure 5).

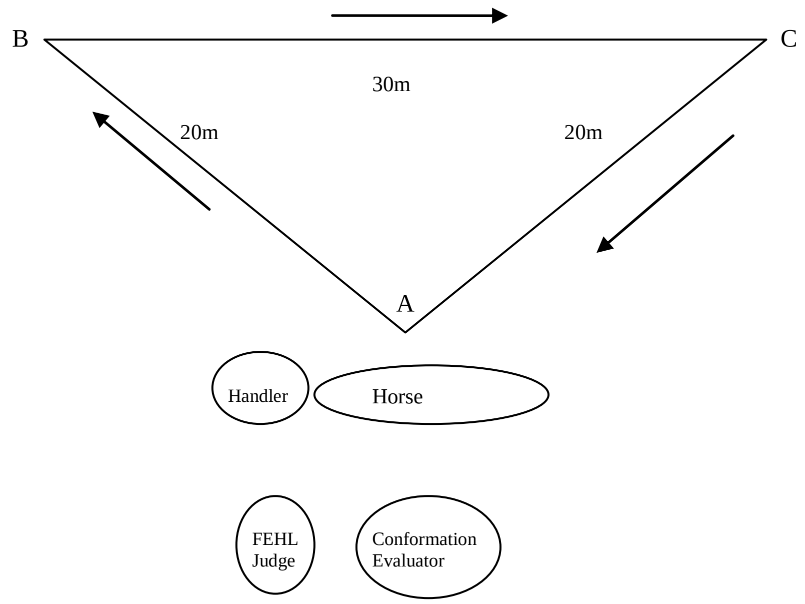


Figure 5: Example of Set-up of Triangle for Trot-up Phase at the FEHL qualifiers

The speed at which the horses were presented to do their trot-up phase was different at every qualifier depending on whether the ridden display phase was judged in two arenas at the same time or just one. In order to move them on quickly judges hurried them through this phase. This resulted in some traits not being scored at some qualifiers in some horses. Other circumstances such as grass height or extremely wet days may not have allowed scoring of some of the traits on some occasions. Additionally if a horse was assessed twice or more, an average of all scores for each trait was calculated and used for further analysis. In Table 3, the number of horses scored in each trait is displayed.

Table 3: Number of Horses Scored within each Trait

Main Traits	Linear Traits	Number of Horses
Head		391
	Shape	347
Neck		364
	Head / Neck Connection	366
	Neck / Body Connection	371
	Length of Neck	364
	Muscling of Neck	360
Saddle Position		371
	Withers	374
	Shoulder	365
Front Leg		379
	Knee	368
	Pastern	373
	Cannon Bone Strength	362
Hind Leg		363
	Gaskin	342
	Quarters	362
	Hock	339
Feet		362
	Foot	358
	Heels	354
Back		357
	Length of Back	359
	Shape of Croup	358
	Loin Muscling	367
Structure		327
	Frame	321
Walk		407
	Stride Length	409
	Deviation	413
Trot		405
	Stride Length	407
	Impulsion	405
	Deviation	398

3.3.1 Conformation Score Sheet

Conformation of potential event horses was analysed by using a combination of a traditional 10 point scale for 10 conformation traits and each trait was further described on a linear scale. Traditionally, in competitions and studbook evaluations in Ireland, conformation is assessed on a continuous scale, which is the case in the FEHL. Therefore a continuous scale for each trait was selected to allow comparison with FEHL results. Additionally each trait was further described in a linear system where two biological extremes lie on either end of the scale and the mid-score describes the midpoint in between those extremes. The score sheet used in this study was developed by the Equestrian Development team of the Royal Dublin Society and the author in order to score the conformation of horses in the Young Event Horse Classes, and the score sheet is currently used by judges at the Dublin Horse Show (Figure 6).

Venue **Catalogue No**

		Poor			Fair			Good								
	Trait	2	3	4	5	6	7	8	9	10	**Profile**					
1	**Head**										Shape of Head	Plain	0	0	0	Fine
2	**Neck**										Head/Neck	Light	0	0	0	Heavy
											Neck/Body	Deep/low	0	0	0	Narrow/high
											Length of Neck	Long	0	0	0	Short
											Muscling of Neck	Poor	0	0	0	Heavy
3	**Saddle Position**										Withers	High	0	0	0	Flat
											Shoulder	Straight	0	0	0	Sloping
4	**Front leg**										Knee	Back	0	0	0	Forward
											Pastern	Weak	0	0	0	Upright
											Bone	Light	0	0	0	Strong
5	**Hind Leg**										Gaskin	Weak	0	0	0	Strong
											Muscularity of Quarters	Poor	0	0	0	Strong
											Hock	Straight	0	0	0	Sickle/curby
6	**Feet**										Foot	Wide	0	0	0	Narrow
											Heels	High	0	0	0	Low
7	**Back**										Length of Back	Long	0	0	0	Short
											Shape of Croup	Sloping	0	0	0	Flat
											Loins/Muscling	Strong	0	0	0	Weak
8	**Structure**										Shape	Rectangular	0	0	0	Square
9	**Walk**										Length of stride	Short	0	0	0	Long
											Correctness	Toed in	0	0	0	Toed out
10	**Trot**										Length of Stride	Short	0	0	0	Long
											Impulsion	Weak	0	0	0	Powerful
											Deviation	Dishing	0	0	0	Plaiting
	Total										**Scorer**					
											Date					

Figure 6: Score Sheet used for Conformation Analysis at FEHL

3.3.2 Test-retest Reliability

The scoring consistency of judges or raters is frequently questioned, therefore a test-retest reliability was carried out. This tests the consistency of the raters (the author) scoring on the conformation measurements from qualifiers. Results from two qualifiers were correlated using Pearson product-moment correlation to produce a stability coefficient. Studying the coefficient provides an evaluation of the consistency of the assessor and/or the test over time. The correlation coefficient depends in part on time and the shorter the time elapsed between measurements the higher the correlation (Huizinga et al., 1991a). For this purpose correlations were carried out between consecutive qualifiers (1 week apart) at the start, middle and end of the FEHL season and the first and last qualifier (3 month apart) of the year, results are displayed in table 4. This was possible as only horses that attended multiple qualifiers were included in the sample. The reliability coefficients range between 0.422 – 0.743, from a modest correlation over the longest time interval to strong correlations between short time intervals (Table 4). Therefore the rater was most accurate in producing the same scores for the same horse over shorter time intervals, which is represented in the higher reliability coefficients. The higher the coefficient, the more consistent the scores of the same horses.

Table 4: Test-retest Reliability of Authors Scoring

Qualifiers	Reliability coefficient
First to second	0.703***
Third and fourth	0.743***
Second last to last	0.587**
First to last	0.422*

* significant at $p < 0.05$, ** significant at $p < 0.01$, *** significant at $p < 0.001$

3.4 Interviews

An interview questionnaire was set up to investigate what type of horse was considered to be suitable for Four Star eventing. Interviews are seen as a qualitative approach to investigate a research area and encourage participation more than postal questionnaires where response rates tend to be very low with 50% or less. This interview was set up to be a research interview, to give a better understanding of reality (Wengraf, 2001). In this case the opinions of Four Star competitors (n = 24) who work with horses of the desired calibre on a daily basis were canvassed. The study used purposeful sampling rather than randomised probability sampling to meet the research objective. Criterion sampling was employed to carry out information-rich and in-depth interviews, therefore quality assurance was met (Wengraf, 2001). In other words the criterion for selection of the sample was that all competitors interviewed had competed at Four Star level. Retrospective questions are affected by the salience of events (Dex and McCulloch, 2001), therefore riders at Four Star level are more likely to remember the qualities of an event horse at that level.

Sampling was carried out by the same interviewer from the 29th May to the 1st of June 2008 at Tattersalls International Horse Trials. The most elite competition run was a CIC***W (Three Star World cup qualifier), this competition was the last qualification venue for the 2008 Olympics in Beijing and therefore the profile of riders and horses was of the top quality of eventing. A total of 24 competitors, entered for the CIC***W, were interviewed. Each of these competitors had previously competed at a Four Star level, which is the highest level of eventing achievable.

3.4.1 Pilot study

A pilot study was carried out to test the relevance of questions, the flow of interview questions and to determine if the length of the questionnaire was appropriate. For the success of the interview, pilot studies were carried out at every stage of the interview question set up (Oppenheim, 2001). Piloting questions is an important practise to investigate interpretation of questionnaire items, which may result in misinterpretations, falsified answers and missing responses (Bowden et al., 2002). Following the pilot study, some questions from the original questionnaire were omitted or rephrased and others added. To minimise interviewer bias 20 of 22 questions were closed question and only 2 questions were open. Additionally, the interviewer was able to practise asking questions consistently in the same way to ensure every participant would get asked every question in the same manner. The pilot study was carried out with 10 colleagues to ensure maximum effectiveness.

3.4.2 Ethics Approval and Sampling at Tattersalls International Horse Trials 2008

The finalised version of the questionnaire, a subject information sheet and a participant declaration form, along with the ethics approval forms, were submitted to the ethics committee of the Physical Education and Sport Science Department and were approved (PESSREC 30/08). Copies of the questionnaire, the subject information sheet and the declaration forms are attached in Appendix 1, 2 and 3.

3.5 Statistical Analysis

The FEHL score sheets provided data regarding age, gender, performance variables on flatwork, conformation and jumping of horses in the study population. The information from the score sheets was used to evaluate differences in scoring between the first and last qualifier that horses attended, by using independent sample t-tests.

Intraclass correlation was used to determine the correlation between scores of two groups of judges at the three suitability and potential phases at FEHL league finals. Benchmark values to determine the strength of agreement between judges were set according to Landis and Koch (1977) as follows: ICC < 0.00 poor agreement, 0.01 to 0.20 slight agreement, 0.21 to 0.40 fair agreement, 0.41 to 0.60 moderate agreement, 0.61 to 0.80 substantial agreement, 0.81 to 1.00 almost perfect agreement. A significant p-value ($p < 0.05$) indicates if the judges' agreement is significantly different from zero, or in other words significantly different from no agreement.

Age of the horses was tested against their average scores achieved in all of the phases using independent sample t-test. The same test was used to determine gender effects. Stallions were omitted from the final sample as the number of stallions was too small for analysis. To analyse any significant differences over the years in scores achieved by horses, analysis of variance (ANOVA) was carried out. In order to reduce type II errors a Bonferroni correction was used for the post hoc analysis. To examine relationships between the different phases within the FEHL, Pearson's correlations were carried out on the sample set.

For evaluation of conformation of the horses that took part in the FEHL in 2007 and 2008, descriptive statistics were used to evaluate all trait. Moreover Pearson's correlation was used to determine comparability between FEHL scoring methods and conformation assessment carried out in this study and whether it has any relevance to the other phases within the FEHL. Data compiled in the interviews was transferred into SPSS 15 for analysis and descriptive statistics were used to provide an overview of the distribution of opinions. Statistical analysis of the entire data was undertaken using the statistical package SPSS 15.

Chapter Four

Research Findings

Chapter 4: Results

4.1 Evaluation of Future Event Horse League Data

4.1.1 Comparison of Judges Scores

At the finals of the Future Event Horse League all horses were scored by two judges in each of the phases. Scored phases included a suitability and potential of the ridden display performed by the horse, suitability and potential of the conformation of the horse and suitability and potential of the horse's jumping. The ridden display phase, where scores are awarded for execution of the test is not assessed on the final day. Instead horses are only assessed on suitability and potential of the ridden display at this phase. Additionally, 4 and 5 year old horses had a different set of judges, therefore Intraclass Correlation Coefficients (ICC) were determined for every phase, every year and by age group of the horses.

The first scored phase Suitability and Potential of the Ridden Display judges showed moderate to substantial agreement with ICC values ranging from 0.445 to 0.885. The highest level of agreement was between judges in 2009 judging the 5 year old horses. And the lowest level of agreement, although still in the moderate range was found between judges in 2007 judging the 5 year old horses. As shown in Table 5, two sets of judges were in the almost perfect agreement category, three sets of judges were in substantial agreement and all others were in moderate agreement and all ICC values were significantly different from zero ($p < 0.05$)

Table 5: Intraclass Correlation Coefficients (ICC), 95% Confidence Intervals (CI) of ICC, F-Statistics and p-value for Judge A and Judge B to Measure Level of Agreement in the Suitability and Potential of Ridden Display Phase

Year	Horse Age	Horses	Judges	ICC	95% CI	F-value	p-value
2005	4	35	2	0.514	0.223 to 0.721	3.12	0.001
	5	27	2	0.589	0.276 to 0.789	3.86	< 0.001
2006	4	25	2	0.567	0.229 to 0.783	3.62	0.001
	5	26	2	0.712	0.455 to 0.860	5.95	< 0.001
2007	4	28	2	0.716	0.474 to 0.858	6.05	< 0.001
	5	30	2	0.445	0.106 to 0.691	2.60	0.006
2008	4	28	2	0.744	0.518 to 0.873	6.81	< 0.001
	5	12	2	0.493	-0.082 to 0.822	2.95	0.043
2009	4	28	2	0.855	0.711 to 0.930	12.82	< 0.001
	5	17	2	0.885	0.713 to 0.957	16.46	< 0.001

The result of the second phase, Suitability and Potential of Conformation, showed that agreement between judges ranged from fair to almost perfect agreement with ICC values ranging from 0.248 to 0.952. The highest level of agreement was between judges in 2009 judging the 4 year old horses. The lowest level of agreement was observed between judges judging the 5 year old horses in 2004. All ICC values were significantly different from zero ($p < 0.05$), except for the 2004 5 year old category which was not significantly different from zero indicating a lack of agreement between judges. Excluding the results from 2004 in the 5 year old category, only one other category of judges' results were in fair agreement, four categories were in moderate agreement, three categories were in substantial agreement and three categories of judges were in almost perfect agreement (Table 6).

Table 6: Intraclass Correlation Coefficients (ICC), 95% Confidence Intervals (CI) of ICC, F-Statistics and p-value for Judge A and Judge B to Measure Level of Agreement in the Suitability and Potential of Conformation Phase

Year	Horse Age	Horses	Judges	ICC	95% CI	F-value	p-value
2004	4	27	2	0.430	0.067 to 0.693	2.51	0.011
	5	21	2	0.248	-0.195 to 0.607	1.66	0.133
2005	4	35	2	0.537	0.252 to 0.736	3.32	< 0.001
	5	24	2	0.621	0.298 to 0.816	4.27	< 0.001
2006	4	25	2	0.739	0.493 to 0.876	6.68	< 0.001
	5	26	2	0.770	0.551 to 0.890	7.70	< 0.001
2007	4	28	2	0.805	0.621 to 0.905	9.26	0.020
	5	30	2	0.370	0.017 to 0.641	2.18	< 0.001
2008	4	28	2	0.591	0.285 to 0.787	3.89	< 0.001
	5	12	2	0.818	0.484 to 0.944	10.00	< 0.001
2009	4	28	2	0.952	0.899 to 0.978	40.84	< 0.001
	5	17	2	0.571	0.141 to 0.820	3.67	0.007

The results of the last phase, Suitability and Potential for Jumping, again showed that agreement between judges ranged from fair to almost perfect agreement with ICC values ranging from 0.393 to 0.836. The highest level of agreement was between judges in 2006, judging the 5 year old horses. The lowest level of agreement and the only pairing of judges in the fair range was found between judges in 2004 judging the 4 year old horses. A summary of the results is displayed in Table 7, with one pairing in fair agreement, three in moderate agreement, seven in substantial agreement and one pairing in almost perfect agreement. All ICC values were significantly different from zero ($p < 0.05$) indicating that all ICC values were significantly different from an absolute lack of agreement.

Table 7: Intraclass Correlation Coefficients (ICC), 95% Confidence Intervals (CI) of ICC, F-Statistics and p-value for Judge A and Judge B to Measure Level of Agreement in the Suitability and Potential for Jumping Phase

Year	Horse Age	Horses	Judges	ICC	95% CI	F-value	p-value
2004	4	27	2	0.393	0.023 to 0.669	2.30	0.019
	5	18	2	0.640	0.260 to 0.848	4.55	0.002
2005	4	35	2	0.687	0.463 to 0.829	5.39	< 0.001
	5	24	2	0.703	0.426 to 0.860	5.74	< 0.001
2006	4	25	2	0.608	0.288 to 0.806	4.11	< 0.001
	5	24	2	0.836	0.657 to 0.926	11.18	< 0.001
2007	4	28	2	0.584	0.275 to 0.783	3.80	< 0.001
	5	25	2	0.427	0.046 to 0.699	2.49	0.015
2008	4	28	2	0.499	0.162 to 0.732	2.99	0.003
	5	12	2	0.736	0.309 to 0.916	6.58	0.002
2009	4	19	2	0.758	0.474 to 0.899	7.28	< 0.001
	5	15	2	0.629	0.191 to 0.858	4.39	0.005

4.1.2 Comparison of First Qualifier Scores and Last Qualifier Scores

There were significant differences found between scores received in the first and last qualifiers attended by horses. Data were available for analysis on the four different phases, Ridden Display scores, Suitability and Potential of Ridden Display, Suitability and Potential of Conformation and Suitability and Potential for Jumping. The interval from the first to the last qualifier a horse attended varied from one week to three months. The number of qualifiers in total a horse attended varied form two qualifiers to ten qualifiers in the same year.

There was a significant difference in mean scores achieved in the Ridden Display from the first to the last qualifier, as shown in Figure 7. The mean scores for Ridden Display in the last qualifier (64.55 ±0.286) were significantly higher (t = -2.324, *df* = 712, 2-tailed *p* = 0.020) than the mean scores for ridden display in the first qualifier (63.86 ±0.294).

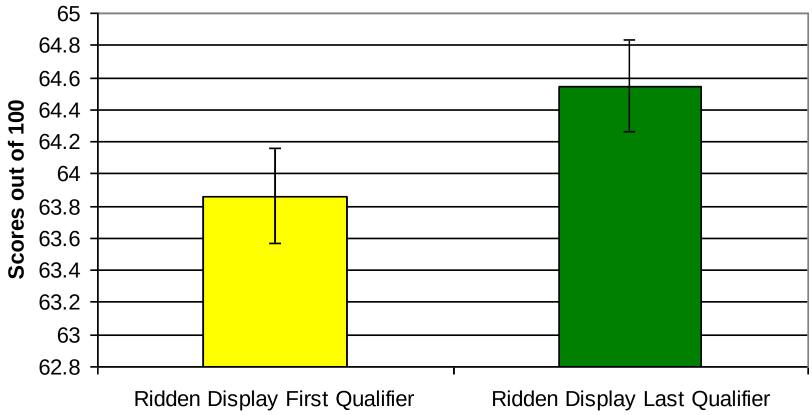


Figure 7: Mean Scores of Ridden Display from First Qualifier to Last Qualifier (n = 713)

All other phases showed no improvement of scores from the first to the last qualifier a horse attended. The mean scores of Suitability and Potential of the Ridden Display, Conformation or for Jumping were found not to be significantly different from the first qualifiers to the last qualifier the horses attended (Table 8).

Table 8: Mean Scores from the First to the Last Qualifier

		N	Mean	t-value	Sig.
Suitability and Potential of Ridden Display	First Qualifier	517	13.63	-0.871	0.384
	Last Qualifier		13.74		
Suitability and Potential of Conformation	First Qualifier	710	13.38	-0.727	0.468
	Last Qualifier		13.46		
Suitability and Potential for Jumping	First Qualifier	648	33.47	0.375	0.708
	Last Qualifier		33.37		

4.1.3 Effect of Age, Gender and Year on Average Scores in Evaluation Phases

4.1.3.1 Effect of Age on Phase Scores

The age of the horse affected mean scores in all scored phases, with 4 year old horses scoring significantly lower in all of 4 phases compared to 5 year old horses (Table 9).

Table 9: Mean Scores in all Four Phases of 4 and 5 Year Old Horses

Phase	Age	Mean ± SD	t-value	Sig.
Ridden Display	4 year old	61.87 ± 5.303	-10.21	< 0.001***
	5 year old	66.43 ± 6.295		
Suitability and Potential of Ridden Display	4 year old	13.41 ± 1.396	-3.90	< 0.001***
	5 year old	13.87 ± 1.269		
Suitability and Potential of Conformation	4 year old	13.37 ± 1.522	-2.17	0.030*
	5 year old	13.63 ± 1.615		
Suitability and Potential of Jumping	4 year old	32.85 ± 4.228	-3.43	0.001***
	5 year old	33.92 ± 3.809		

* significant at $p < 0.05$, *** significant at $p \leq 0.001$

In the Ridden Display phase 4 year old horses (61.87 ± 0.269) scored significantly lower (t = -10.212, *df* = 607.789, two-tailed sig. $p < 0.001$) mean scores compared to 5 year old horses (66.43 ± 0.356), as shown in Figure 8.

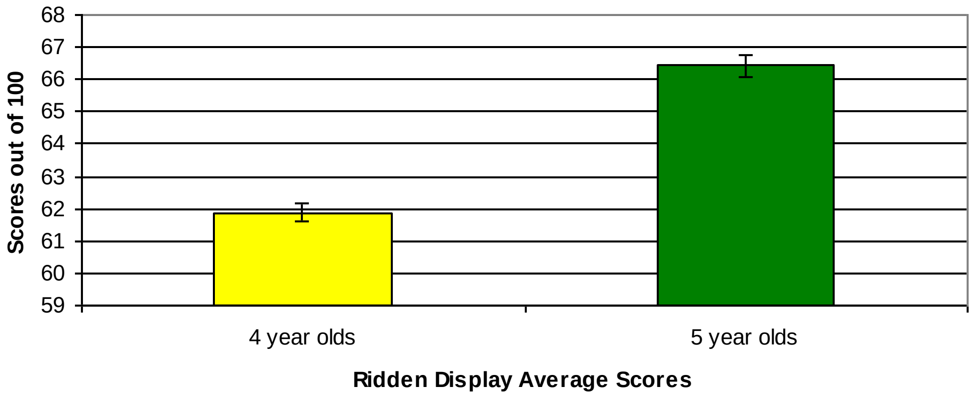


Figure 8: Mean Scores of 4 and 5 year olds in the Ridden Display (n = 702)

Four year old horses (13.41 ± 0.083) scored significantly lower values (t = -3.895, *df* = 507.787, two-tailed sig. $p < 0.001$) than 5 year old horses (13.87 ± 0.084) in Suitability and Potential of Ridden Display (Figure 9).

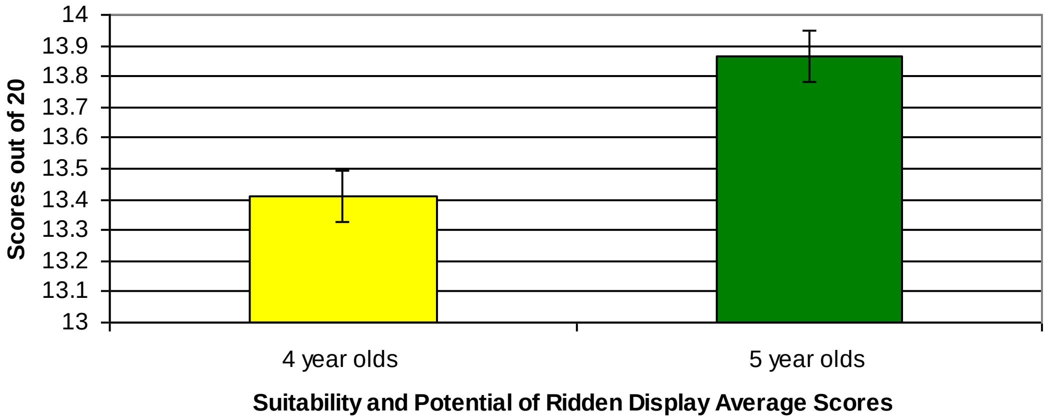


Figure 9: Mean Scores of 4 and 5 year olds in the Suitability and Potential of Ridden Display (n = 517)

The independent t-test shows that 4 year old horses (13.37 ±0.077) scored significantly lower (t = -2.169, *df* = 698, two-tailed sig. $p = 0.030$) than 5 year olds (13.63 ± 0.092) in Suitability and Potential of Conformation (Figure 10).

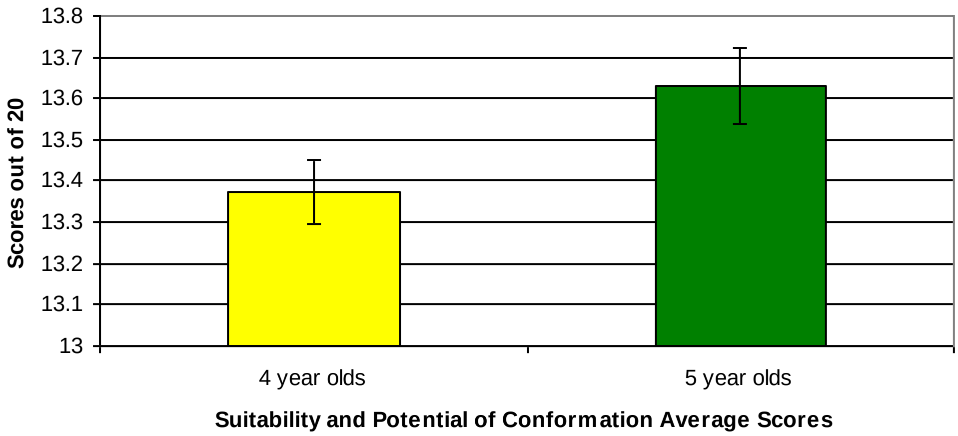


Figure 10: Mean Scores of 4 and 5 year olds in the Suitability and Potential of Conformation (n = 700)

Figure 11 displays, that 4 year old horses (32.85 ± 0.218) scored significantly lower (t = -3.434, *df* = 651.004, two-tailed sig. *p* = 0.001) than 5 year old horses (33.92 ±0.223) in Suitability and Potential for Jumping.

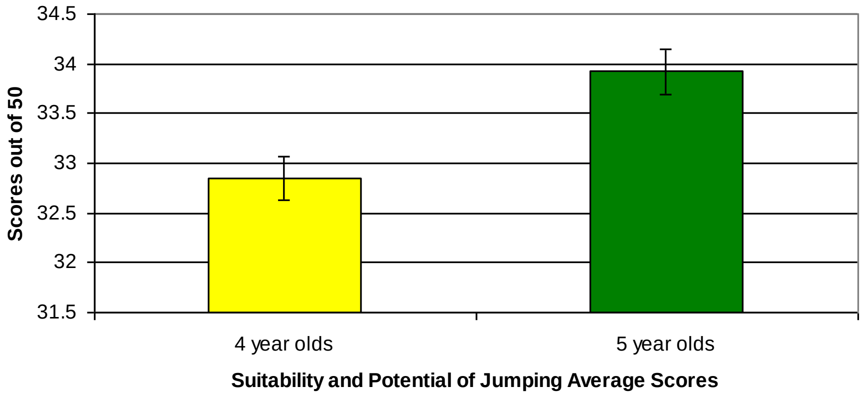


Figure 11: Mean Scores of 4 and 5 year olds in the Suitability and Potential of Jumping (n = 667)

4.1.3.2 Effect of Gender on Phase Scores

Gender had a significant effect on the Suitability and Potential of Ridden Display phase and the Suitability and Potential of Conformation phase. Gender had no effect on scores given for the Ridden Display and Suitability and Potential for Jumping phase (Table 10).

Table 10: Results of Independent T-tests for Mean Scores in all Four Phases of Mares and Geldings

Phase	Gender	Mean ± SD	t-value	Sig.
Ridden Display	Mare	63.91 ± 6.164	0.11	0.913
	Gelding	63.97 ± 6.237		
Suitability and Potential of Ridden Display	Mare	13.32 ± 1.441	2.89	0.004**
	Gelding	13.73 ± 1.326		
Suitability and Potential of Conformation	Mare	13.14 ± 1.610	3.34	0.001***
	Gelding	13.61 ± 1.528		
Suitability and Potential of Jumping	Mare	33.15 ± 4.110	0.69	0.492
	Gelding	33.41 ± 4.074		

** significant at $p < 0.01$, *** significant at $p \leq 0.001$

Geldings (13.73 ± 0.067) scored significantly higher (t = 2.885, *df* = 502, two-tailed sig. $p = 0.022$) in Suitability and Potential of Ridden Display than mares (13.32 ± 0.134), as shown in Figure 12.

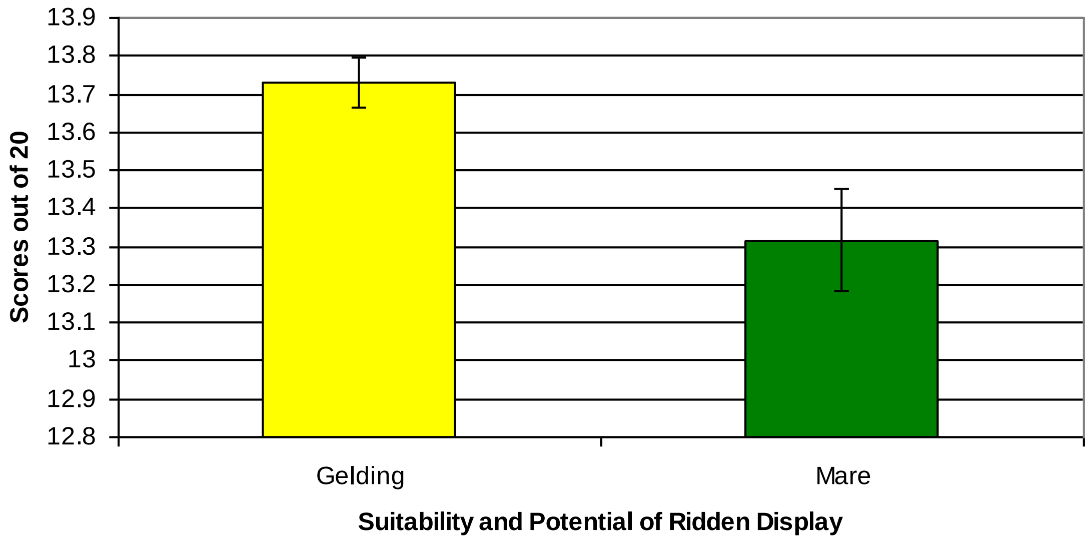


Figure 12: Mean Scores of Geldings and Mares in the Suitability and Potential of Ridden Display (n = 504)

The independent t-test shows that geldings (13.61 ± 0.067) scored significantly higher (t = 3.340, *df* = 678, two-tailed sig. $p = 0.001$) than mares (13.14 ±0.128) in Suitability and Potential of Conformation (Figure 13).

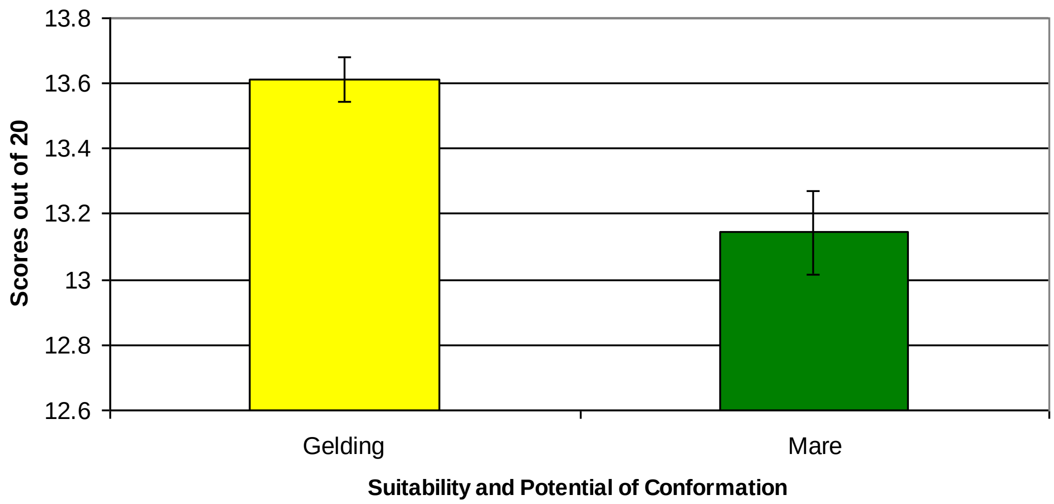


Figure 13: Mean Scores of Geldings and Mares in the Suitability and Potential of Conformation (n = 680)

4.1.3.3 Effect of Year on Phase Scores

In order to determine trends over years, analysis of average scores recorded over five years was carried out using one-way ANOVA with Bonferroni correction applied.

There was a significant difference between average Ridden Display scores in different years ($p < 0.001$). Scores in years 2006 and 2007 (66.60 ±0.522) were significantly ($p < 0.05$) higher than 2005 and 2009, but did not differ significantly ($p > 0.05$) from each other. The mean score of 2008 (60.14 ±0.473) was significantly ($p < 0.05$) lower than all other years. Mean scores from year 2005 (63.14 ±0.529), 2006 (65.48 ±0.543) and 2009 (63.143 ±0.493) were not significantly different ($p > 0.05$) from 2004 (64.73 ±0.714) mean scores, as shown in Figure 14.

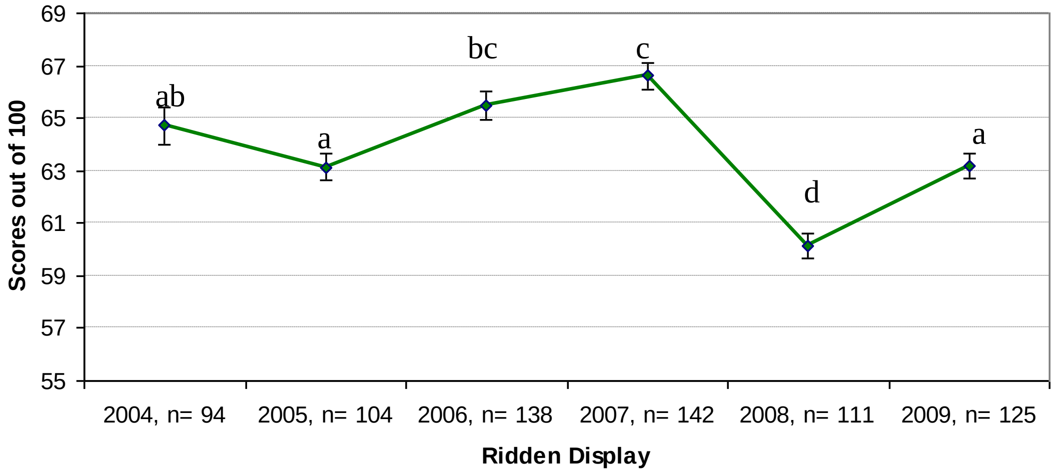


Figure 14: Effect of Year on Mean Ridden Display Scores (n = 714)

The Suitability and Potential of Ridden Display phase was introduced in 2006 for the first time, therefore analysis was only carried out on years 2006, 2007 and 2008.

Significant differences were found in average Suitability and Potential of Ridden Display scores between years ($p < 0.001$). Average scores in 2007 (14.05 ±0.121) were significantly higher than in 2006 (13.42 ±0.121), 2008 (13.43 ±0.109) and 2009 (13.50 ±0.113). Mean scores in 2006, 2008 and 2009 did not significantly differ ($p <0.05$), as shown in Figure 15.

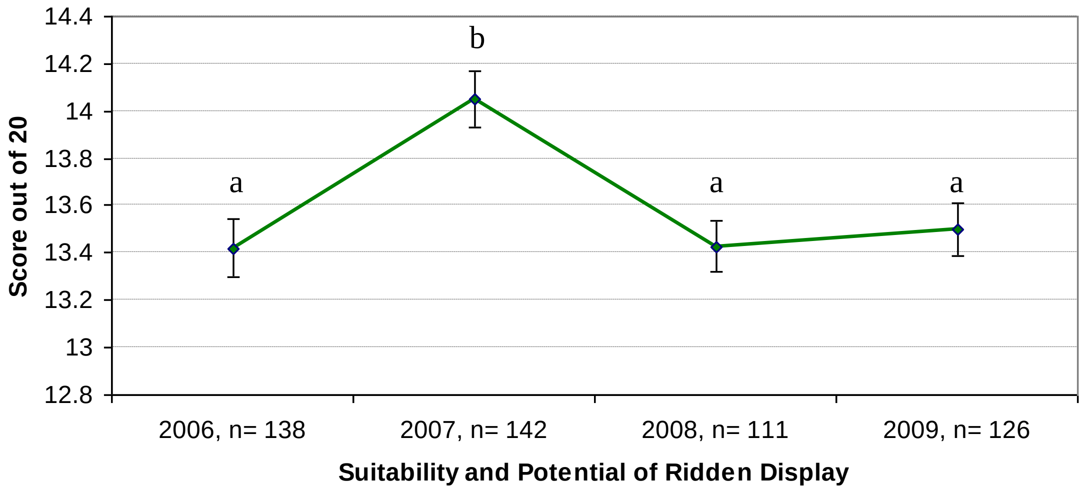


Figure 15: Effect of Year on Mean Suitability and Potential of Ridden Display Scores (n = 517)

Figure 16 shows how average scores for Suitability and Potential of Conformation were significantly different by year ($p < 0.001$). Mean scores for conformation were significantly lower ($p < 0.05$) in 2004 (13.41 ±0.158), 2007 (13.36 ±0.138) and 2009 (13.51 ±0.141) compared to 2005 (13.98 ±0.127) and 2006 (13.92 ±0.130). There were no significant ($p > 0.05$) differences between 2004, 2007 and 2009 or 2005 and 2006 in the mean Suitability and Potential of Conformation scores. In 2008, scores (12.70 ±0.136) for suitability and potential of conformation were significantly ($p < 0.05$) lower compared to all other years.

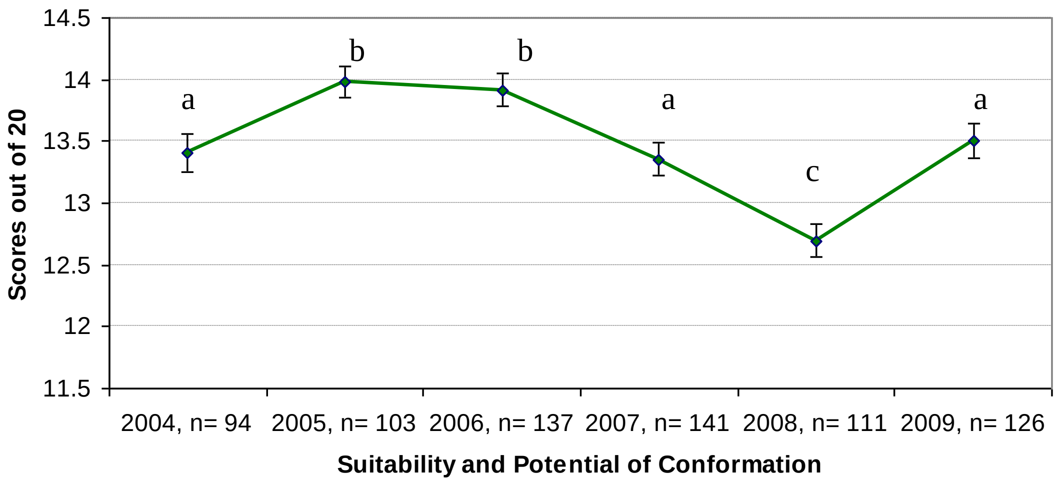


Figure 16: Effect of Year on Mean Suitability and Potential of Conformation Scores (n = 712)

Average Suitability and Potential of Jumping scores from different years were significantly different ($p < 0.001$). Years 2005 (34.34 ±0.419), 2006 (33.00 ±0.348) and 2007 (34.13 ±0.364) were not significantly ($p > 0.05$) different from mean scores in 2004 (33.31 ±0.417). Mean scores for 2005 and 2007 were significantly different ($p < 0.05$) compared with 2006. In contrast to that 2005 and 2007 scores were not different to each other ($p > 0.05$). The average scores for 2009 (33.45 ±0.347) were not significantly different from any of the years, except from 2008. Mean scores for Suitability and Potential for Jumping in 2008 (31.41 ±0.352) were significantly lower ($p < 0.05$) compared to all other years' scores (Figure 17).

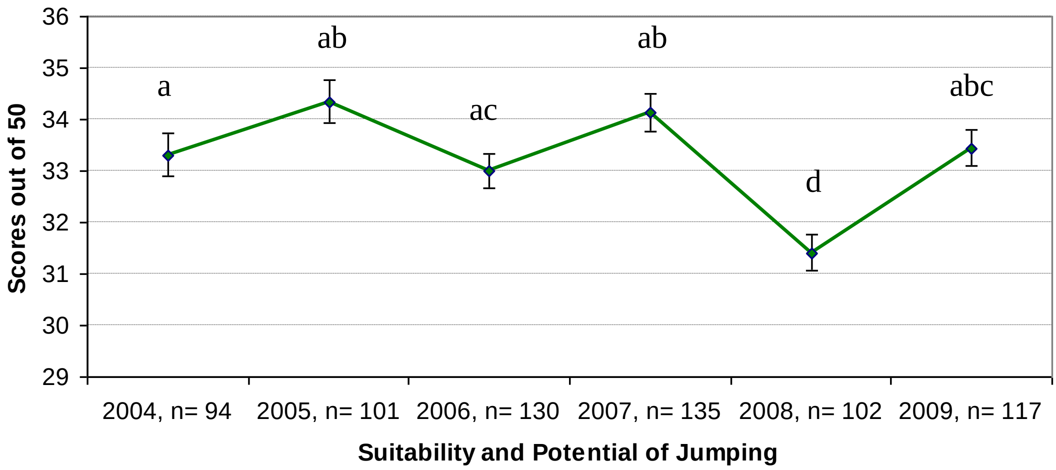


Figure 17: Effect of Year on Mean Suitability and Potential of Jumping Scores (n = 679)

4.1.3.4 Effect of Breed on Phase Scores

In order to examine the difference in breeds over the years a chi-square test was carried out. Horses with either the dam or sire or both registered with studbooks outside of Ireland were classed as Foreign bred, the remainder were classed as Irish bred.

There was no significant difference ($\chi^2 = 6.799$, df = 3, $p = 0.079$) between the number of Irish bred and Foreign bred horses during each year from 2006 – 2009 inclusive (Figure 18).

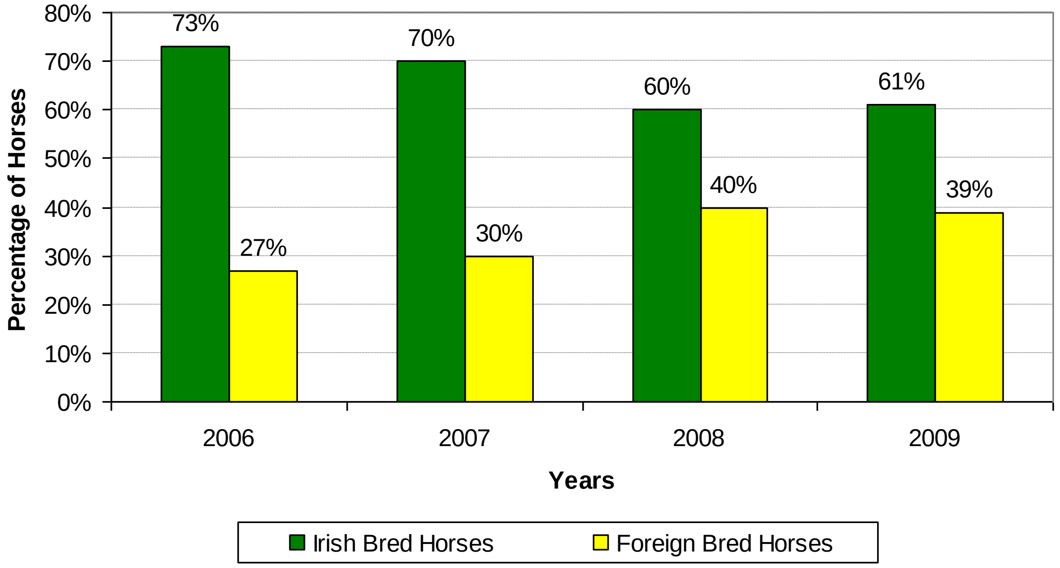


Figure 18: Percentage of Irish and Foreign Bred Horses in FEHL from 2006 to 2009 (n = 513)

To determine differences in results between Irish and Foreign bred horses independent t-test were carried out, results of these are shown in Table 11. All phases, except Suitability and Potential of Ridden Display, showed no significant differences between breeds.

Table 11: Mean Scores in all Four Phases of Irish and Foreign Bred Horses

Phase	Breed	N	Mean ± SE	t-value	Sig.
Ridden Display	Irish	342	63.98 ± 0.352	-0.532	0.595
	Foreign	170	64.28 ± 0.455		
Suitability and Potential of Ridden Display	Irish	342	13.52 ± 0.074	-2.457	0.015*
	Foreign	171	13.82 ± 0.102		
Suitability and Potential of Conformation	Irish	340	13.34 ± 0.090	-1.285	0.200
	Foreign	171	13.53 ± 0.115		
Suitability and Potential of Jumping	Irish	319	33.04 ± 0.230	-0.574	0.566
	Foreign	161	33.26 ± 0.304		

* significant at $p < 0.05$

Figure 19 illustrates the difference in mean Suitability and Potential of the Ridden Display scores between Irish and Foreign bred horses. Irish bred horses (13.52 ± 0.074) scored significantly lower (t = -2.457, *df* = 349.503, two-tailed sig. p = 0.015) than Foreign bred horses (13.82 ± 0.102) in this phase.

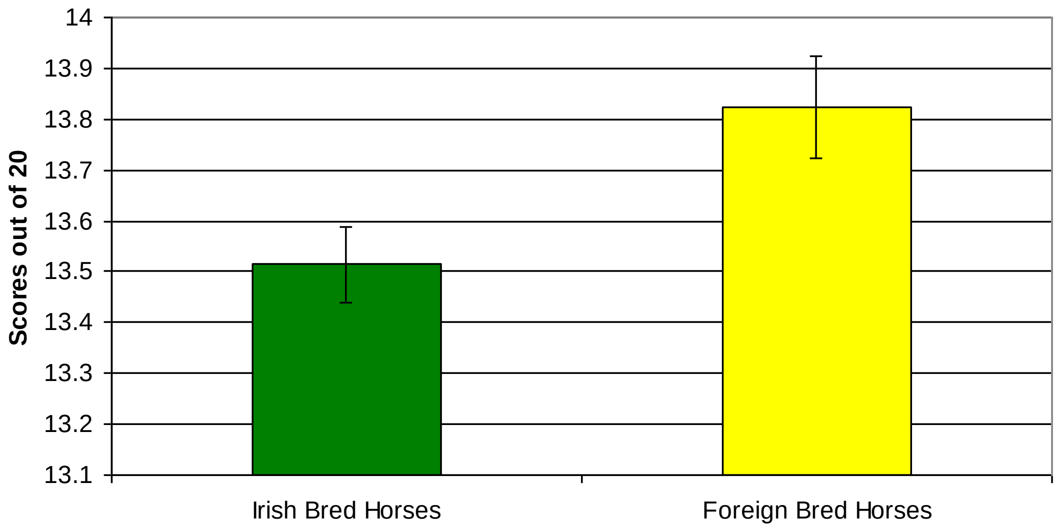


Figure 19: Mean Scores of Irish Bred and Foreign Bred Horses in the Suitability and Potential of Ridden Display (n = 513)

The Irish bred horses included purebred thoroughbred horses; a high degree of thoroughbred blood is traditionally desired in eventing. To see potential differences between breeds analyses was carried out on mean scores in each competition between; purebred thoroughbred horses, Irish and Foreign bred horses. Results of this analysis are shown in Table 12. There were no significant differences observed in Ridden Display results or Suitability and Potential of Ridden Conformation results between breeds ($p > 0.05$). Significant differences were found in Suitability and Potential of Ridden Display and Suitability and Potential of Jumping ($p < 0.05$).

Table 12: ANOVA for Mean Scores in all Four Phases of Irish Bred Horses, Foreign Bred Horses and Thoroughbred Horses

Phase	Breed	N	Mean ± SE	Sig.
Ridden Display	Irish	317	64.12 ± 0.366	0.437
	Foreign	170	64.24 ± 0.451	
	TB	25	62.51 ± 1.370	
Suitability and Potential of Ridden Display	Irish	317	13.55 ± 0.077	0.017*
	Foreign	171	13.82 ± 0.102	
	TB	25	13.12 ± 0.284	
Suitability and Potential of Conformation	Irish	315	13.31 ± 0.093	0.251
	Foreign	171	13.53 ± 0.115	
	TB	25	13.68 ± 0.341	
Suitability and Potential of Jumping	Irish	296	33.27 ± 0.235	0.001***
	Foreign	161	33.27 ± 0.305	
	TB	23	30.12 ± 0.783	

*significant at $p < 0.05$, ***significant at $p \leq 0.001$

Foreign bred horses scored significantly higher ($p < 0.05$) mean scores (13.82 ± 0.10) for Suitability and Potential of Ridden Display than both Irish bred (13.55 ± 0.077) and thoroughbred horses (13.12 ± 0.284). Average scores for Irish bred horses and thoroughbred horses did not significantly differ ($p > 0.05$), as shown in Figure 20.

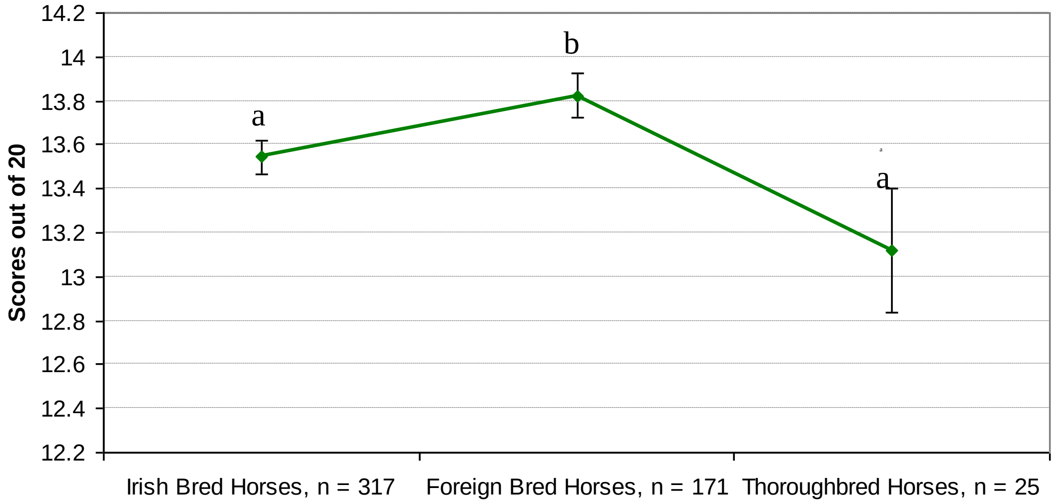


Figure 20: Effect of Breed on Mean Suitability and Potential of Ridden Display Scores

As presented in Figure 21, there were no significant differences ($p > 0.05$) seen in mean Suitability and Potential Scores for Jumping between Irish bred (33.27 ± 0.235) and Foreign bred horses (33.27 ± 0.305). Thoroughbred horses (30.12 ± 0.783) scored on average significantly lower ($p \leq 0.001$) in this phase than Irish bred and Foreign bred horses.

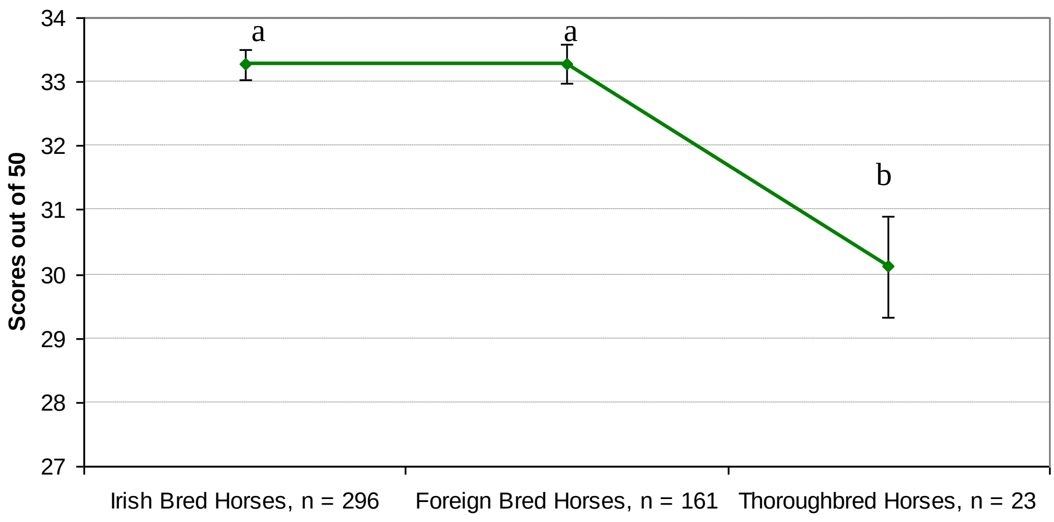


Figure 21: Effect of Breed on Mean Suitability and Potential of Jumping Scores

4.1.4 Correlations of Scores between the Different Phases

Investigations of interaction between the different scored phases of the Future Event Horse League were tested using Pearson's bivariate correlation analysis. The phases were correlated and results are shown in Table 13, with positive Pearson's correlation values ranging from 0.12 to 0.52. The strongest relationship was found between Suitability and Potential of Conformation and the Suitability and Potential of the Ridden Display and the weakest relationship was between the Ridden Display and the Suitability and Potential for Jumping. There was no relationship found between Suitability and Potential of Conformation scores and the Ridden Display scores. All significant relationships are shown in figures 22, 23, 24, 25, 26 and 27, where with the increase of one score there was a significant increase of the other. Both Suitability and Potential of Ridden Display and Suitability and Potential for Jumping were related with all other scored phases. With an increase in any of the scores there was a significant increase in these two phases indicating a positive association. Correlations were interpreted as follows: 0.00 – no correlation, 0.01 – 0.19 very weak correlation, 0.20 –

0.39 weak correlation, 0.40 – 0.69 modest correlation, 0.70 – 0.89 strong correlation, 0.90 – 0.99 very strong correlation, 1.00 perfect correlation.

Table 13: Bivariate Correlations between Judge Scored Phases

	Ridden Display	S&P of Ridden Display	Conformation	S&P of Jumping
Ridden Display	-	0.481***	0.276***	0.338***
S&P of Ridden Display	0.481***	-	0.535***	0.383***
Conformation	0.276***	0.535***	-	0.392***
S&P of Jumping	0.338***	0.383***	0.392***	-

*** Significant at $p < 0.001$

There was a significant positive relationship between Ridden Display scores and scores for Suitability and Potential of the Ridden Display (r = 0.481, d.f. = 514, $p < 0.001$). Horses with high scores in the Ridden Display tended to have high scores for Suitability and Potential of Ridden Display, with a modest correlation displayed (Figure 22).

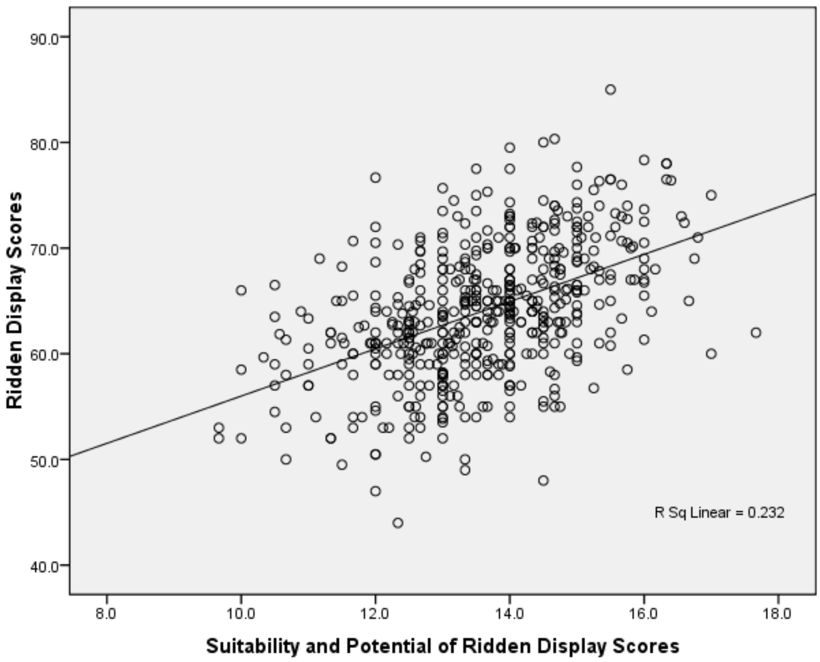


Figure 22: Relationship between Ridden Display Scores and Suitability and Potential of Ridden Display Scores (n = 516)

Although a weak correlation, there was a significant positive relationship between scores for Suitability and Potential of Conformation and the Suitability and Potential for Jumping ($r = 0.392$, d.f. = 676, $p < 0.001$). Horses with high scores for Conformation tended also to score well higher in Suitability and Potential of Jumping (Figure 23).

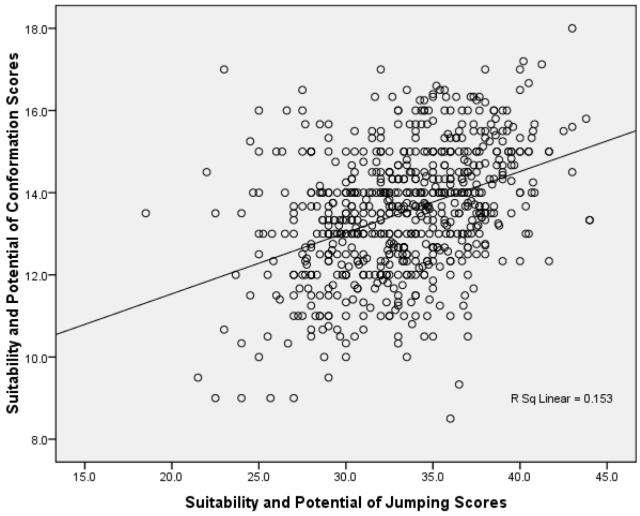


Figure 23: Scatter Plot showing the Relationship between Suitability and Potential of Conformation Scores and Suitability and Potential of Jumping Scores (n = 678)

There was a significant positive relationship between the Suitability and Potential of Conformation and scores for Suitability and Potential of Ridden Display ($r = 0.535$, d.f. = 513, $p < 0.001$). The modest correlation indicates that horses scoring high in the Conformation phase of the competition tended to score high in Suitability and Potential of Ridden Display (Figure 24).

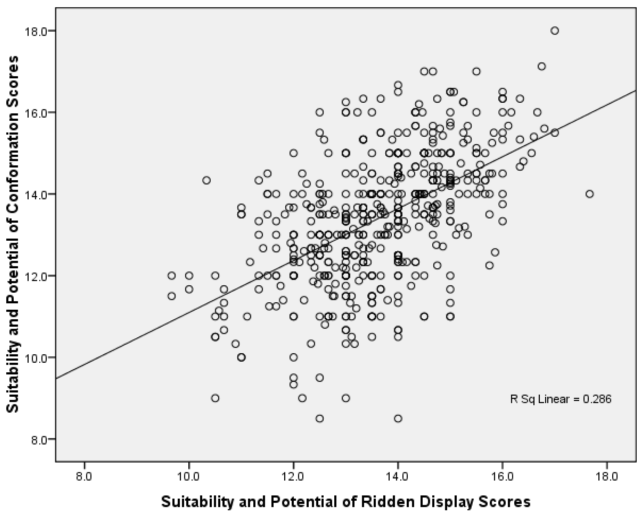


Figure 24: Scatter Plot showing the Relationship between Suitability and Potential of Conformation Scores and Suitability and Potential of Ridden Display Scores (n = 515)

Although a weak correlation, there was a significant positive relationship of scores for Suitability and Potential for Jumping and Suitability and Potential of Ridden Display (r = 0.383, d.f. = 482, $p < 0.001$). Those horses scoring high in Suitability and Potential for Jumping had a tendency to score high in Suitability and Potential of the Ridden Display (Figure 25).

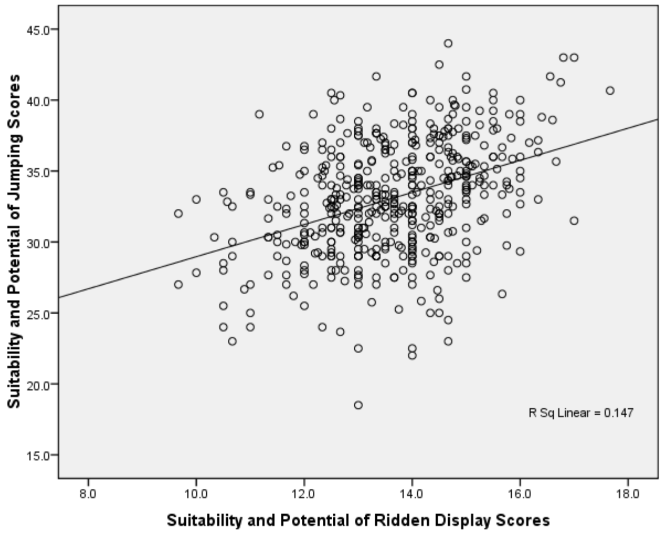


Figure 25: Scatter Plot showing the Relationship between Suitability and Potential of Jumping Scores and Suitability and Potential of Ridden Display Scores (n = 484)

There was a significant positive relationship between the Ridden Display scores and the scores for Suitability and Potential for Jumping (r = 0.338, d.f. = 676, $p < 0.001$), however the correlation was weak As horses scored high in the Ridden Display they tended to score high in Suitability and Potential of Jumping (Figure 26).

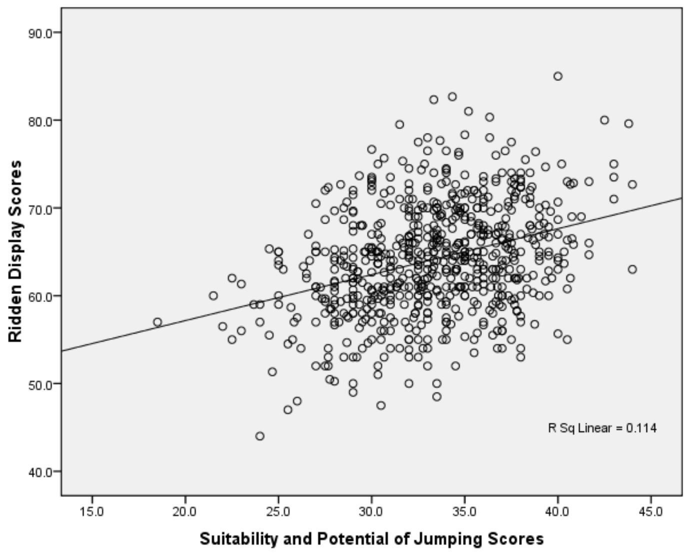


Figure 26: Scatter Plot showing the Relationship between Ridden Display Scores and Suitability and Potential of Jumping Scores (n = 678)

The weak correlation observed, displayed a significant positive relationship of scores for Suitability and Potential for Conformation and Suitability and Ridden Display (r = 0.276, d.f. = 708, $p < 0.001$). Those horses scoring high in Suitability and Potential for Conformation had a tendency to score high in the Ridden Display (Figure 27).

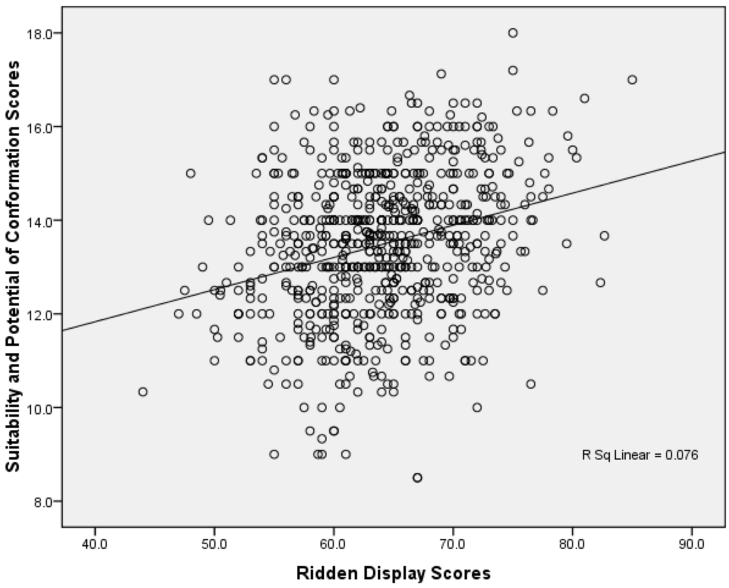


Figure 27: Scatter Plot showing the Relationship between Suitability and Potential of Conformation Scores and Ridden Display Scores (n = 678)

4.1.5 Comparison of Traditional Scores and New Conformation Scores

In order to determine whether the more informative conformation score sheet is applicable and comparable to the traditional system used, a bivariate correlation was carried out with all scored phases of the Future Event Horse League. The results of the bivariate correlations between the traditional scores and the more descriptive conformation scores showed a significant association between three of the four scored phases evaluated in the Future Event Horse League. The Pearson's correlation values range from 0.246 – 0.473 (Table 14). Correlations were interpreted as follows: 0.00 – no correlation, 0.01 – 0.19 very weak correlation, 0.20 – 0.39 weak correlation, 0.40 – 0.69 modest correlation, 0.70 – 0.89 strong correlation, 0.90 – 0.99 very strong correlation, 1.00 perfect correlation.

Table 14: Correlations between Traditional Scored Phases and Scored Conformation

	N	Conformation	Sig.
Ridden Display	214	-0.088	0.201
Suitability and Potential of Ridden Display	214	0.386	< 0.001***
Suitability and Potential of Conformation	214	0.473	< 0.001***
Suitability and Potential of Jumping	202	0.246	< 0.001***

*** significant at $p < 0.001$

Suitability and Potential of Ridden Display scores were significantly positively correlated with new conformation scores (r = 0.386, *df* = 212, $p < 0.001$), however the correlation was interpreted as weak. Horses that scored highly in Suitability and Potential of Ridden Display also scored highly in conformation, as shown in Figure 28.

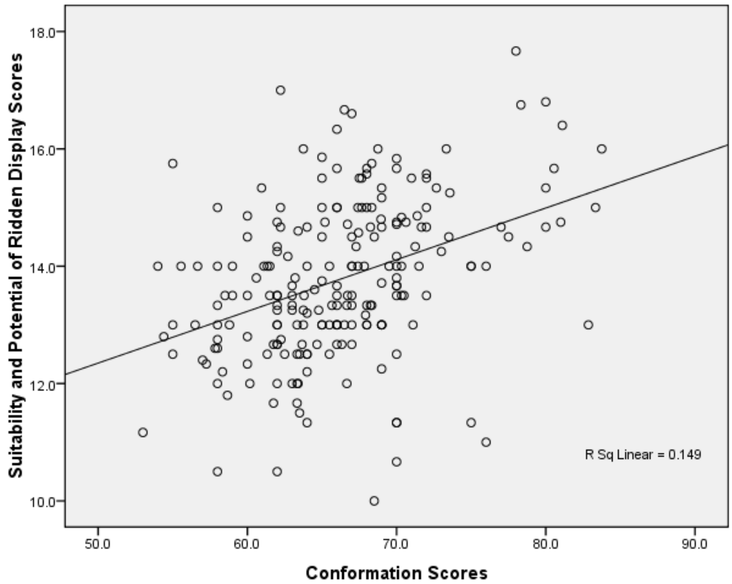


Figure 28: Relationship between Conformation Scores and Suitability and Potential of Ridden Display Scores (n = 214)

The new conformation scores and Suitability and Potential conformation scores were significantly positively correlated with the r-value indicating a modest relationship (r = 0.473, *df* = 212, $p < 0.001$). The higher a horse scored in one evaluation method the higher it scored in the other (Figure 29).

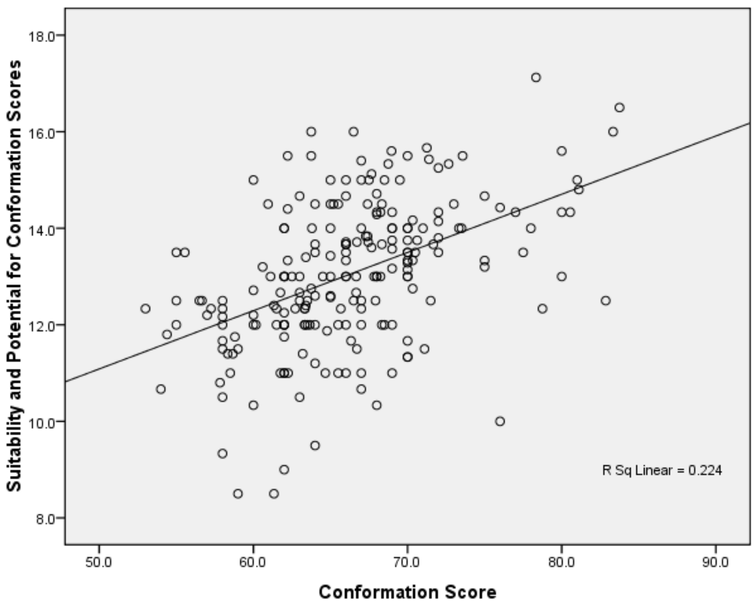


Figure 29: Scatter Plot showing the Relationship between Conformation Scores and Suitability and Potential of Conformation Scores (n = 214)

Although a weak correlation, there was a significant positive relationship between the new conformation scores and the scores for Suitability and Potential of Jumping (r = 0.246, *df* = 200, *p* <0.001). A horse receiving high scores for jumping also tended to receive high scores for linear conformation, as displayed in Figure 30.

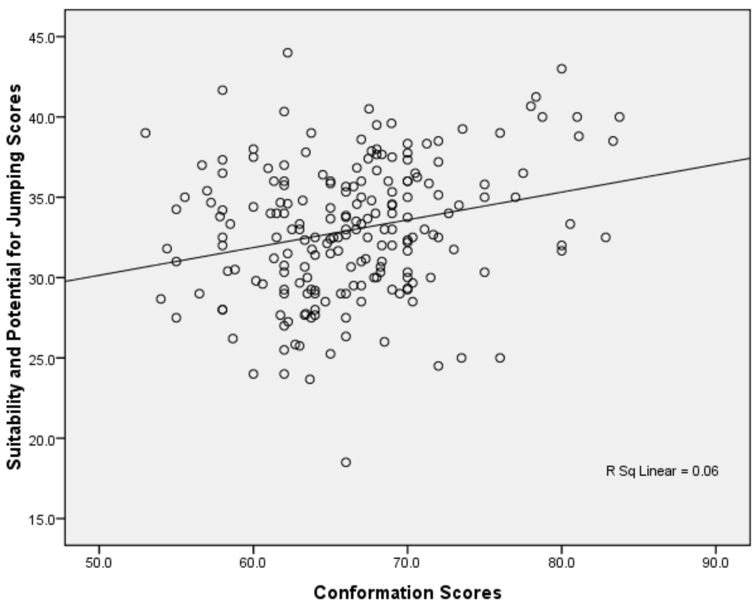


Figure 30: Scatter Plot showing the Relationship between Conformation Scores and Suitability and Potential of Jumping Scores (n = 202)

4.2 Interview Questionnaire Results

4.2.1 Descriptive Statistics

Interviews with 24 top level competitors were carried out. These interviews were designed to give information with regard to the type of horse that is selected for four star level eventing. Of the 24 competitors interviewed, half were male and half were female. In Figure 31, the age distribution of competitors interviewed is shown.

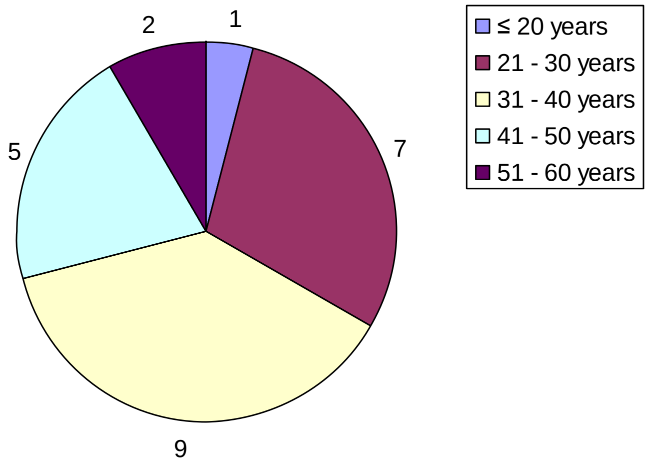


Figure 31: Pie Chart of Age Distribution of Competitors Interviewed

Competitors were asked to rate price, temperament, conformation, pedigree and movement in order of importance as selection criteria of event horses. In total 56.5% rated temperament as the most important criteria, 21.7% rated price as the most important, 13.0% rated conformation as the most important and 8.7% rated movement as the most important. None of the competitors rated pedigree as the most important (Figure 32). Age and gender did not affect the answers on selection criteria ($p > 0.05$).

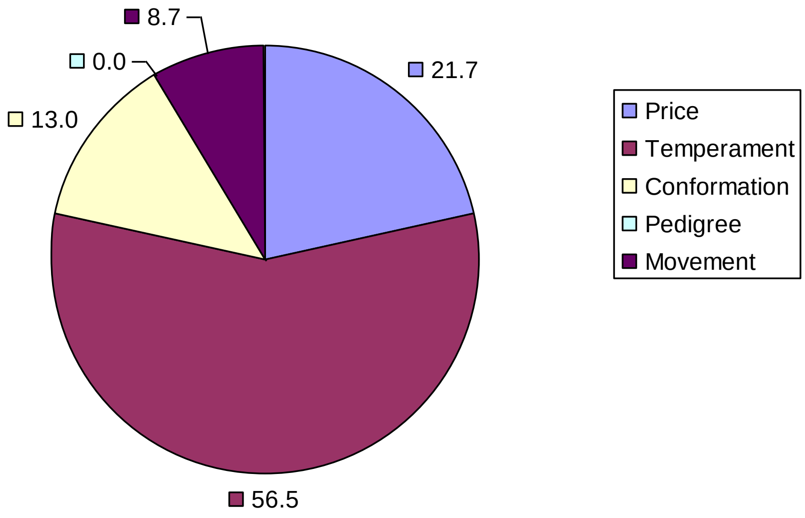


Figure 32: Pie Chart on Rating the Importance of the Selection Criteria for Eventing (n = 23)

The distribution of age profiles of horses most commonly bought by competitors for eventing are shown in figure 33. While the majority of competitors (29.2%) buy horses at 4 years of age, the second largest proportion buy horses at 3 years of age (20.8%). An equal percentage of 16.7% of competitors buy horses at age 5 and 6. A small percentage of 12.5% of competitors buy horses of any age. None of the competitors interviewed buy horses between 0 to 2 years of age.

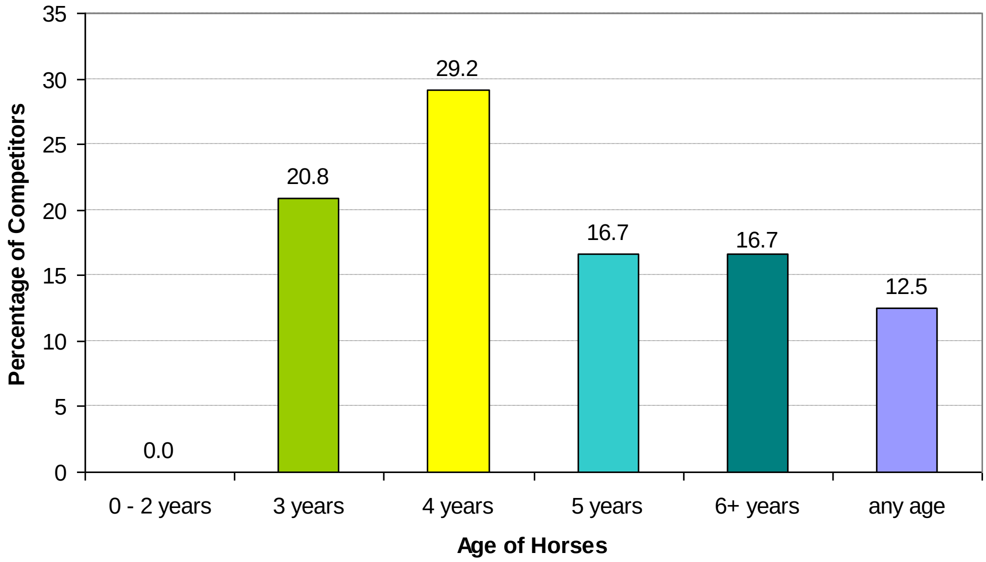


Figure 33: Distribution of Age Profile of Horses Bought for the Sport (n = 24)

The most suitable breed for eventing according to the competitors was Irish Sport Horse crossed with thoroughbred (56.5%), it needs to be pointed out that the sample size of interviews was a quite small. Another 17.4% of competitors responded that thoroughbred was the most suitable, followed by Irish Sport Horse (13.0%), 8.7% thought breeds other than the ones mentioned were the most suitable and 4.3% indicated German bred horses. None of the competitors selected Selle Francais or KWPN (Dutch Warmblood) as most suitable for eventing (Figure 34).

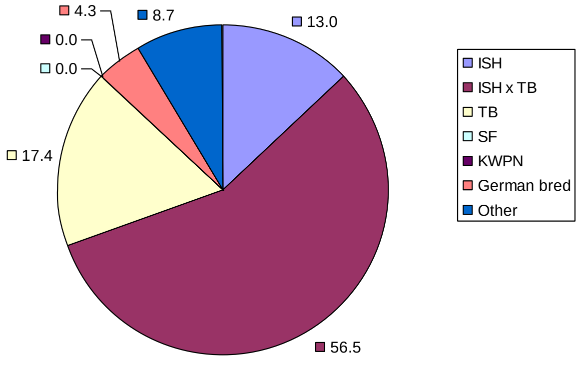


Figure 34: Pie Chart on Suitability of Breeds for Eventing (n = 23)

Competitors were asked which of the Irish breeds were the most suitable for eventing. The majority of competitors (82.6%) stated that Irish Sport Horse crossed with thoroughbred was the most suitable, 8.7% considered that the traditional Irish Draught crossed with thoroughbred was most suitable and 4.3% thought that other Irish crosses or Irish Sport Horse crossed with Foreign breeding were most suitable (Figure 35).

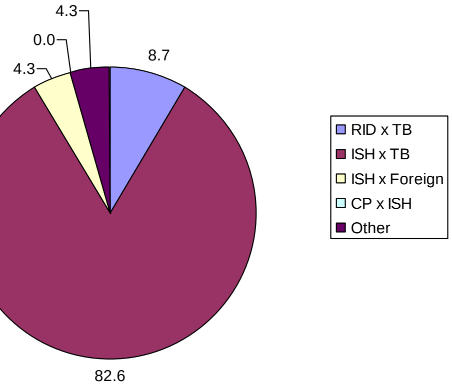


Figure 35: Pie Chart on Suitability of Irish Bred Horses for Eventing (n = 23)

In response to where the competitors most frequently bought their horses, the majority of 54.5% stated private vendors as a source, 18.2% bought at all of the possible options and 18.2% stated other, without specifying any further. A smaller proportion (9.1%) of competitors bought mainly at sport horse auction, as shown in figure 36.

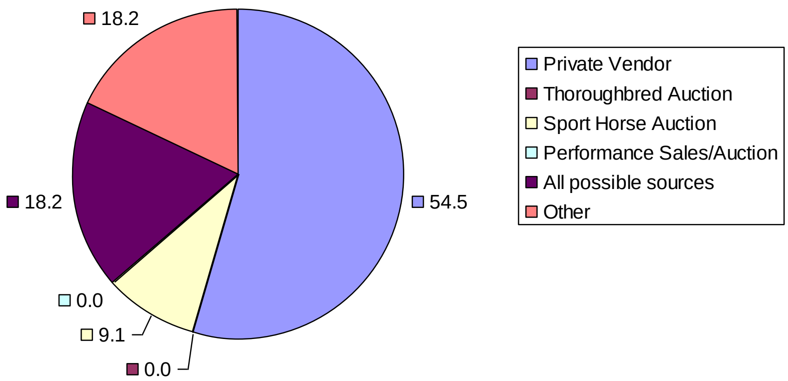


Figure 36: Pie Chart on the Sourcing of Event Horses by Competitors (n = 22)

The competitors were asked how much money they would consider spending on a 3 year old horse which they would consider suitable for the sport. Of the respondents 8.7% would spend €2,500, just over a quarter (26.1%) of competitors would be prepared to spend €5,000. A total of 30.4% of competitors would be prepared to spend up to €10,000 and a slightly smaller percentage (21.7%) was prepared to spend up to €15,000. Only a small percentage (4.3%) indicated that they would spend up to €20,000 and a total of 8.7% responded they would be prepared to spend in excess of €20,000 (Figure 37). Age or gender had no affect on how much competitors were prepared to spend.

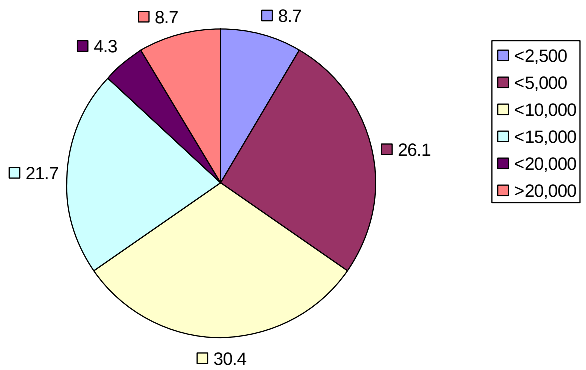


Figure 37: Pie Chart on How Much Competitors Would Spend on 3-Year Old Horses (n = 23)

Interviews with competitors at four star level may give an indication of what type of horse, with regard to conformation, is required at the top level of eventing. The competitors are familiar with the physical demands placed on horses at this level of competition and have informed opinions on the required conformation. Competitors were asked to rate on a linear scale what they consider ideal conformation within each trait. The linear scale competitors were given was a five point scale, where each end of the scale described the biological extremes of that trait. The midpoint of the scale represents the midpoint of the biological scale. In between this midpoint and the biological extreme lies a weaker version of that extreme. For example a light head-neck connection lies on one end of the scale and on the opposite end of the scale was a heavy head-neck connection. The midpoint is neither a light nor a heavy head neck connection and between this midpoint and a heavy connection lies a slightly heavy head-neck connection. In reference to the midpoint the term average is used in this section, as it commonly describes the population average. Table 15 shows a summary of all the conformation trait results.

Table 15: Opinions of 4 Star Competitors on Ideal Conformation for Event Horses (n = 24)

Trait	Biological Extreme			Midpoint			Biological Extreme
Head/Neck Connection	Light	25%	20.8%	50%	4.2%	-	Heavy
Neck/Body Connection	Deep	12.5%	4.2%	16.7%	45.8%	20.8%	Narrow
Length of Neck	Long	4.2%	16.7%	75%	4.2%	-	Short
Muscling of Neck	Poor	-	-	16.7%	58.3%	25%	Topline
Withers	High	4.2%	20.8%	75%	-	-	Flat
Shoulder	Straight	-	-	20.8%	20.8%	58.3%	Sloping
Knee	Back	-	-	66.7%	33.3%	-	Forward/Over
Pastern	Long	-	4.2%	54.2%	33.3%	8.3%	Short
Bone	Light	-	16.7%	37.5%	33.3%	12.5%	Heavy
Gaskin	Weak	-	-	16.7%	12.5%	70.8%	Strong
Quarters	Weak	-	-	4.2%	20.8%	75%	Strong
Hock	Straight	-	-	83.3%	16.7%	-	Sickle
Feet	Wide	4.2%	-	87.5%	4.2%	4.2%	Narrow
Heels	High	12.5%	41.7%	45.8%	-	-	Low
Length of Back	Long	-	4.2%	50%	29.2%	16.7%	Short
Shape of Croup	Sloping	16.7%	33.3%	41.7%	4.2%	4.2%	Flat

Trait	Biological Extreme			Midpoint			Biological Extreme
Loin	Strong	62.5%	16.7%	16.7%	4.2%	-	Weak
Shape	Rectangular	-	20.8%	29.2%	29.2%	20.8%	Square
Stridelength at Walk	Short	-	-	4.2%	16.7%	79.2%	Long
Correctness of the Walk	Toed in	-	-	100%	-	-	Toed out
Stridelength at Trot	Short	-	-	37.5%	37.5%	25%	Long
Impulsion at Trot	Weak	-	-	12.5%	29.2%	58.3%	Powerful
Correctness of the Trot	Dishing	-	-	100%	-	-	Plaiting
Stridelength at Canter	Short	-	8.3%	37.5%	37.5%	12.5%	Long
Impulsion at Canter	Weak	-	-	8.3%	25%	66.7%	Powerful

Half of the competitors, 50%, preferred an average head-neck connection. A light head-neck connection was preferred by 25% and a slightly light connection was rated as preferential by 20.8%. Only a very small proportion of 4.2% preferred a slightly heavy head neck-connection. A total of 45.8% of competitors preferred a slightly narrow/high neck-body connection. A further 20.8% favoured a narrow/high neck-body connection. An average connection was preferred by 16.7%. Another 12.5% suggested a deep connection to be ideal while 4.2% preferred a slightly deep connection. An average length of neck was favoured by 75% of competitors. A total of 16.7% preferred slightly long necks while 4.2% preferred long necks. Slightly short necks were favoured by only 4.2% and none of the competitors favoured a short neck. When asked about muscling of the neck 58.3% of respondents preferred to see a little neck topline developed. A further 25% indicated that the topline should be developed strongly. A smaller proportion of 16.7% of competitors felt that an average muscling of the neck was ideal. When asked about the ideal wither conformation, 75% agreed that a medium wither height was ideal. Some 20.8% indicated a preference to slightly high withers while a further 4.2% answered that a high wither conformation was ideal. The largest proportion (58.3%) of competitors preferred a sloping shoulder. Similar percentages (20.8%) favoured the shoulder to be slightly sloping or of average conformation. Evaluation of conformation in the front leg, 66.7% of competitors agreed that the ideal knee conformation lies in the midpoint of the biological extremes. However 33.3% preferred a slightly forward conformation of the knee. None of the competitors favoured the back at the knee conformation. Pastern conformation in between biological extremes was preferred by 54.2% of competitors. A total of 33.3% favoured pasterns to be slightly short and a further 8.3% preferred them to be short. Only a small percentage of 4.2% thought that the ideal pastern should be slightly long. Average cannon bone substance was thought to be ideal by 37.5% of the competitors. Almost as many (33.3%) favoured slightly heavy bone substance in the front cannon and 12.5% favoured heavy substance. Another 16.7% of competitors indicated slightly light cannon bone substance as the ideal. A very large proportion of the interviewed competitors (70.8%) preferred strong gaskins in the hindleg. A smaller percentage of 12.5% preferred slightly strong gaskins and 16.7% favoured average gaskin conformation. Similar trends were observed concerning the competitors' opinions on muscularity of the quarters. The largest proportion (75%) of competitors stated that they preferred strong muscling of the hindquarters. A smaller proportion of 20.8% still favoured a slightly strong muscling of the hindquarters and 4.2% considered the ideal hindquarter muscling to be within the population average. Desirable hock conformation was perceived to be ideal at the midpoint of scale by 83.3% of competitors. A minority of competitors (16.7%) preferred a slightly sickle conformation of the hock. None of the respondents indicated straight hock as a desirable trait. The majority (87.5%) of competitors favoured average hoof width. An equal percentage (4.2%) of interviewed competitors stated slightly narrow, narrow or wide hoof widths. Average heel height was favoured by 45.8% of competitors; a further 41.7% favoured a slightly higher heel height. A small percentage (12.5%) considered high heel height to be the ideal. In response to the question on the ideal back length for event horses 50% responded that average back length was ideal, 29.2% preferred a slightly shorter back and 16.7% considered a short back length as ideal. A smaller percentage (4.2%) preferred a slightly long back for event horses. Average shape/slope of the croup was considered to be the ideal conformation by 41.7%. Another 33.3% thought that a slightly sloping croup was ideal while a further 16.7% answered that a sloping croup was the ideal conformation. A minority of 4.2% stated that a slightly flat or flat croup would be of advantage. The majority of competitors (62.5%) preferred strong loin conformation, whereas another 16.7% responded that slightly strong loin conformation was ideal. A similar percentage (16.7%) felt that average loin conformation to be ideal and only a small percentage (4.2%) favoured a slightly weak loin area. The relationship between height at withers and the length between point of shoulder and point of buttocks describes the structure of shape of the horse. If both are equal the horse is square and if it is shorter in height than in length, the horse is rectangular in structure. An equal proportion (29.2%) of competitors preferred average or a slightly square shape for event horses. Additionally 20.8% responded that a square shape was ideal and the same proportion felt that a slightly rectangular shape would be ideal. In response to the question what length of stride in the walk would be ideal for an event horse, 79.2% considered that a long stride was ideal. A further 16.7% favoured a slightly long stride whereas only a small percentage (4.2%) felt that average stride length was ideal. None of the respondents favoured a short stride length. All competitors (100%) stated that they did not want a deviation of the flight path of the foot and therefore the midpoint of the scale was selected for ideal movement at the walk. In the opinion of 75% of competitors average stride length at trot or slightly long stride length was ideal for an event horse. Another 25% thought that a long stride length was advantageous. None of the respondents favoured a short stride length at the trot. A powerful impulsion in trot was preferred by 58.3%, a slightly powerful impulsion was preferred by 29.2% and a further 12.5% favour average impulsion. In relation to deviation at the trot, all competitors agreed that the midpoint between the biological extremes was the most appropriate trait, representing no deviation. A total of 39.1% of competitors favoured an average stride length at the canter/gallop and a similar proportion felt that a slightly long stride would be ideal. A long stride length at the canter/gallop was favoured by 13.0% and a slightly short stride length was favoured by 8.7%. A powerful impulsion at the canter and gallop was preferred by 66.7% of respondents, 25% preferred a slightly powerful impulsion and only 8.3% considered average impulsion ideal.

4.2.2 Open Answer Questions

Answers to the question regarding what type of abnormality in conformation competitors would consider a hindrance in the sport are displayed in Table 16. This was an open question, competitors were able to express their opinions with no restrictions to the number of possible answers and some competitors gave more than one answer. The majority of abnormalities listed related to the limbs. Out of all competitors 54.2% stated that they consider abnormalities in foot/hoof conformation as a hindrance. A further 41.7% listed pastern conformation, where long, sloping, short and upright pasterns were considered as a disadvantage. Another common answer (37.5%) was leg abnormality. This was highlighted by 25% of competitors who felt that crooked legs were not desirable. More specifically in the leg, knee conformation was highlighted to be a problem by 33.3% of competitors, 29.2% stated a back at the knee conformation and 4.2% a back at the knee or tied in below the knee to be a hindrance in the sport. The remaining traits associated with abnormalities by competitors included cannon bone, hock, back, shoulder, neck, quarter and other abnormalities.

Table 16: Opinions of Competitors on the type of abnormalities in conformation considered a hindrance in the sport

Trait	**Abnormalities**	**% of Competitors**
Cannon bone		**20.8%**
	Long cannon bone	16.7%
	Light of bone	4.2%
Hock		**29.2%**
	Bad hock	4.2%
	Straight hock	12.5%
	Weak hock	8.3%
	Curby hocks	4.2%
Pastern		**41.7%**
	Long pastern	29.2%
	Sloping pastern	8.3%
	Short upright or long	4.2%
Feet		**54.2%**
	Flat feet	16.7%
	Bad feet	37.5
Back		**25%**
	Long back	16.7%
	Bad back	4.2%
	Sway back	4.2%
Shoulder	straight	**4.2%**
Knee		**33.3%**
	Back at the knee	29.2%
	Back at the knee or tied in	4.2%
Legs		**37.5%**
	Crooked	25%
	Bad angles	4.2%
	Weak hindlegs	4.2%
	curb	4.2%
Neck		**12.5%**
	Low set	8.3%
	Long neck	4.2%
Quarters		**16.7%**
	Unlevel	8.3%
	Croup high	8.3%
Other		**12.5%**
	Rounded joints	4.2%
	dishing	8.3%

In Table 17 the competitors responses on individual selection criteria employed are shown. Half of the competitors responded that temperament was an important criterion for selection of event horses. Furthermore, 37.5% of the competitors questioned referred to the attitude of the horse. This was followed by the third most frequent answer of conformation where different aspects of the conformation of the horse were listed. Athletic ability, good paces, the horse as a whole / health and price were other selection criteria mentioned.

Table 17: Answers of Competitors to "When buying an event horse: What are your criteria for selection?"

Selection Criteria		**% of Competitors**
Horse as a whole		**16.7%**
Conformation		**33.3%**
	Sloping croup depth	16.7%
	Conformation in general	12.5%
	Powerful gaskin, good shoulder and uphill built	4.2%
	Limbs	4.2%
Attitude of horses		**37.5%**
Temperament		**50%**
Price		**4.2%**
Good Paces		**20.8%**
	Good walk and canter	8.3%
	Movement	12.5%
Athletic ability / performance		**25%**

4.3 Evaluation of Descriptive Conformation Traits

4.3.1 Descriptive Statistics of Main Traits

The 10 main conformation traits of the new proposed method were scored similar to a traditional scoring method by giving a quantitative score out of 10. Each main trait was further described using a linear system, which described conformation of that particular trait in regard to the biological extremes. For the descriptive analysis of the main traits data from two years of FEHL (2007, 2008) and a total of 413 individual horses were used. This analysis was carried out to demonstrate an overview of the population's distribution of scores, giving some indication of the quality of the traits.

The distribution of average conformation scores for individual traits ranged from 6.20 as the lowest mean for the structure of the horse to 6.90 representing the highest mean for hoof conformation. The minimum and maximum values of the scale used are represented in Table 18, the minimum value available was 2 and the maximum was 10. The full range of scores was used for head and trot conformation evaluation. A further 4 traits used 8 of the 9 available scores and another 4 trait used 7 of the 9 available representing the narrowest range used.

Table 18: Range, Mean and Standard Deviations for the Main Conformation Traits

Conformation Trait	Range		Mean	S.D.	Horses
	Min	Max			
Head	2	10	6.85	1.271	391
Neck	3	10	6.80	1.177	364
Saddle Position	4	10	6.81	1.067	371
Frontlegs	3	9	6.22	1.242	379
Hindlegs	3	9	6.39	1.060	363
Hoof	2	9	6.90	1.241	362
Back	2	9	6.24	1.177	357
Structure	3	10	6.20	1.170	327
Walk	4	10	6.58	1.068	407
Trot	2	10	6.36	1.154	405

In the following traits, scores from 2-4 represent poor conformation, 5-7 represent fair conformation and 8-10 represent a good conformation within these traits (Figures 32 – 41).

Percentage distribution of scores for head conformation shows that most horses lie in the fair region of scores. The largest proportion of horses scored a 7 and the second largest proportion scoring 8 (Figure 32).

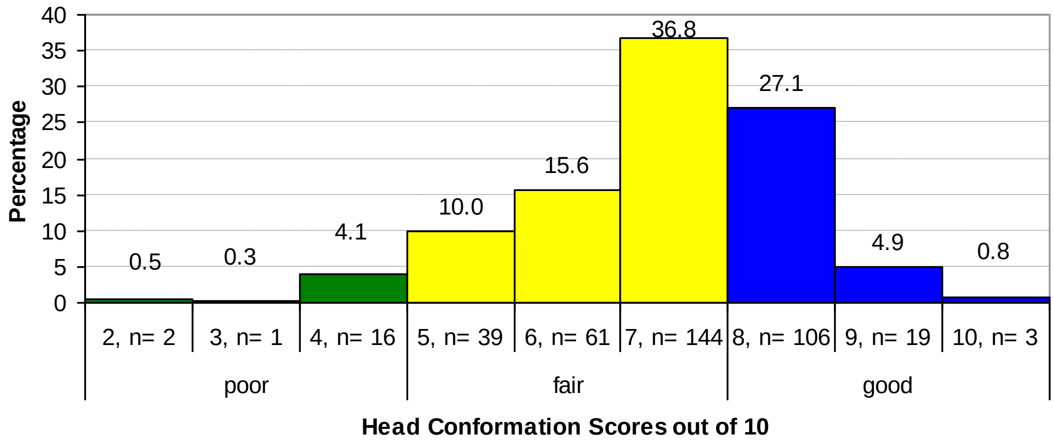


Figure 32: Distribution of Scores out of 10 for Head Conformation (n = 391)

Figure 33 shows the distribution of scores for neck conformation of all horses. The highest percentage, 38.5% of horses, scored 7 and a quarter of the population of horses scored 8.

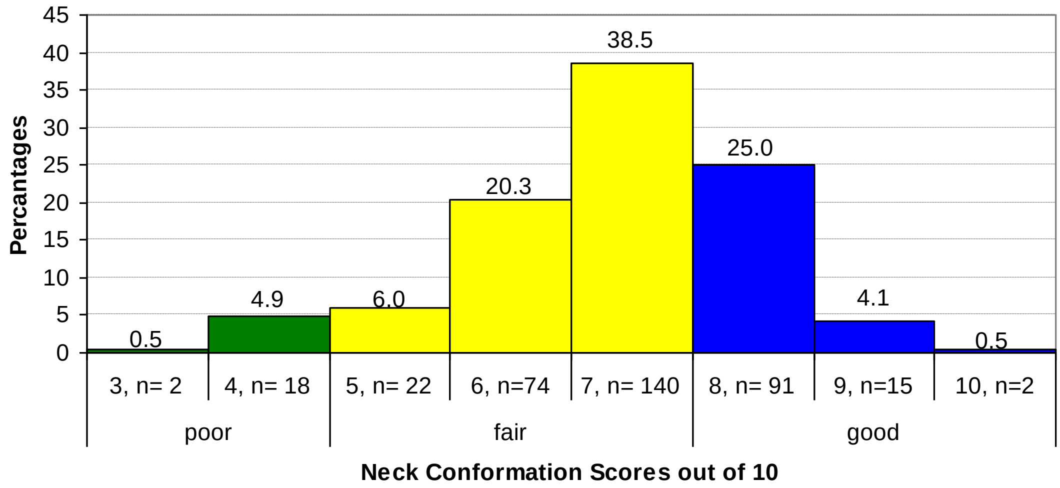


Figure 33: Distribution of Scores out of 10 for Neck Conformation (n = 364)

The distribution of saddle conformation scores showed only 2.4% of horses scored poorly (4). More than two thirds of horses (68.7%) scored fair marks (5-7) and a total of 28.8%, representing almost one third of horses, scored good marks (8-10) for saddle position (Figure 34).

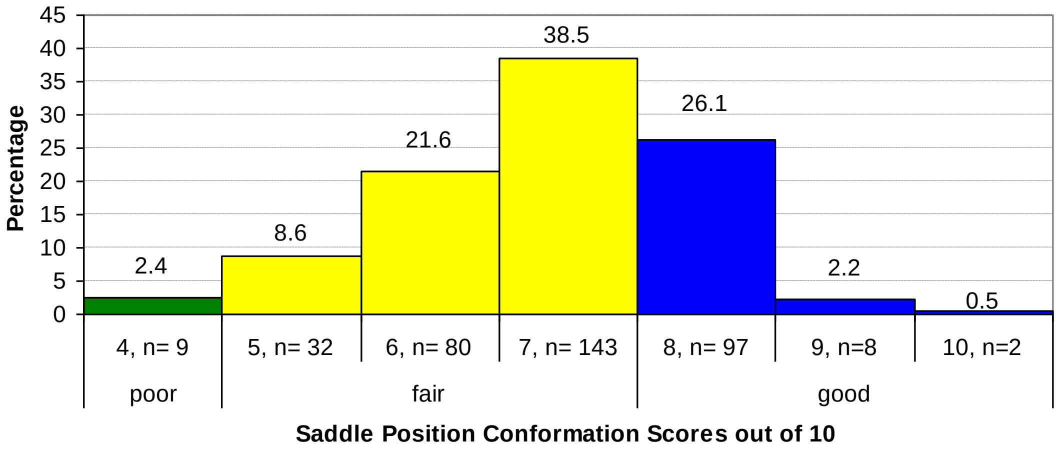


Figure 34: Distribution of Scores out of 10 for Saddle Position Conformation (n = 371)

Foreleg conformation scores of the population revealed 74.2% of horses scored fair marks (5-7) and a small percentage of 15.6% scored good marks while a smaller percentage of 10.3% scored poor marks (3-4). Similar to the three previous figures, most horses scored 7 for foreleg conformation (Figure 35).

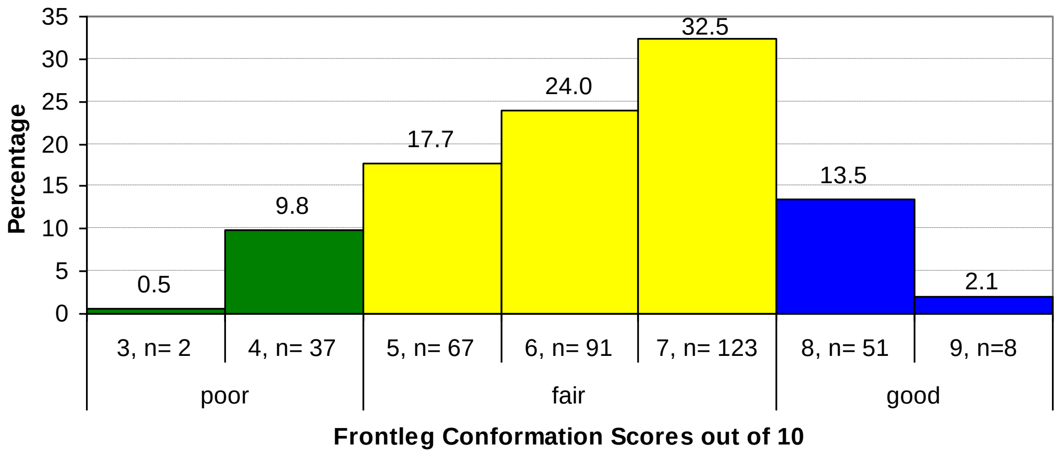


Figure 35: Distribution of Scores out of 10 for Frontleg Conformation (n = 379)

With respect to conformation of the hindlegs, very few horses scored poor marks. The majority 79.1% of horses scored fair marks (5-7) leaving only few (17.4%) horses scoring good marks (8-9), as shown in Figure 36.

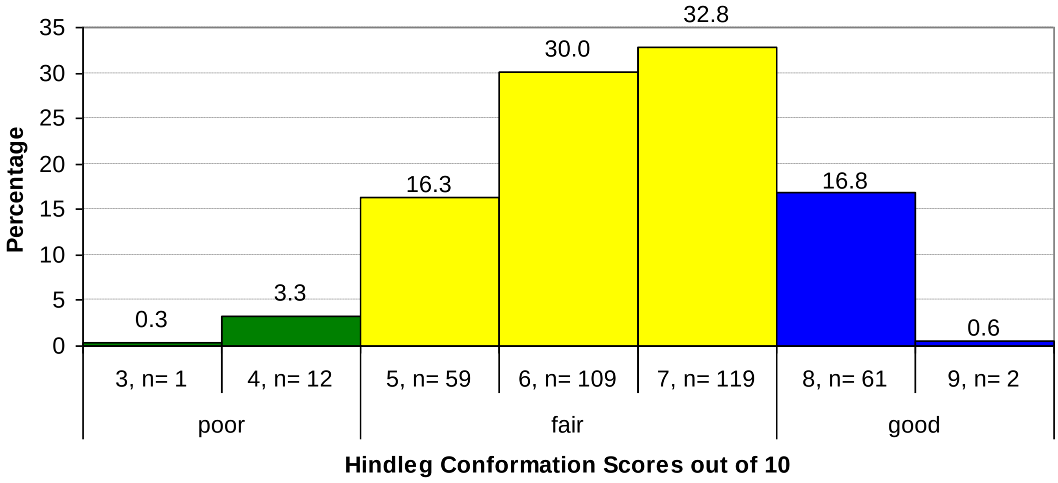


Figure 36: Distribution of Scores out of 10 for Hindleg Conformation (n = 363)

The distribution of foot or hoof conformation scores differed to the previous distribution recorded for hindleg conformation. The largest percentage of horses, 35.6%, scored 8 and 32.3% of horses scored 7 for hoof/foot conformation (Figure 37).

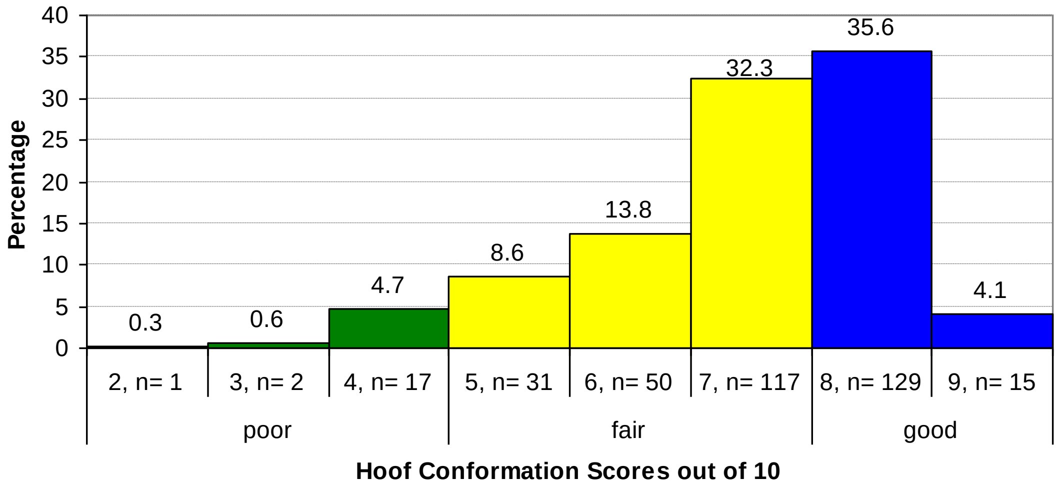


Figure 37: Distribution of Scores out of 10 for Hoof Conformation (n = 362)

Back conformation was slightly shifted towards the middle of the scale, with 32.5% of horses scoring 6, which represented the midpoint of scale. Additionally, 29.1% of horses scored 7 for back conformation. A relatively small percentage (7.6%) of horses scored poorly (2-4) and a larger proportion (15.4%) of horses scored good (8-9), as shown in Figure 38.

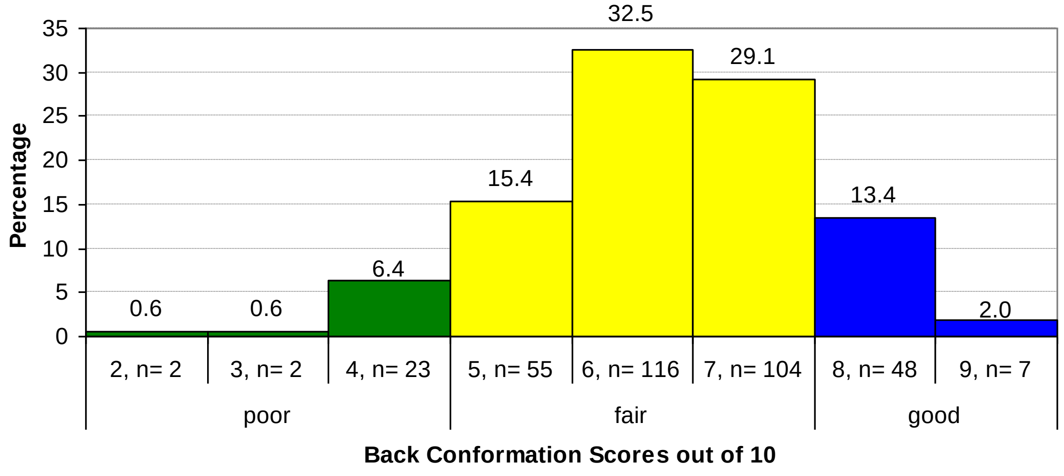


Figure 38: Distribution of Scores out of 10 for Back Conformation (n = 357)

The scores for structure of conformation, shown in Figure 39, were distributed similarly to the above. The largest proportion of horses (35.5%) scored the midpoint score of 6 and this was within the largest grouping (80.8%) that scored fair marks (5-7). Almost three times the amount of horses (14.0%) scored good (8-10) compared to the horses (5.2%) that scored poorly (3-4).

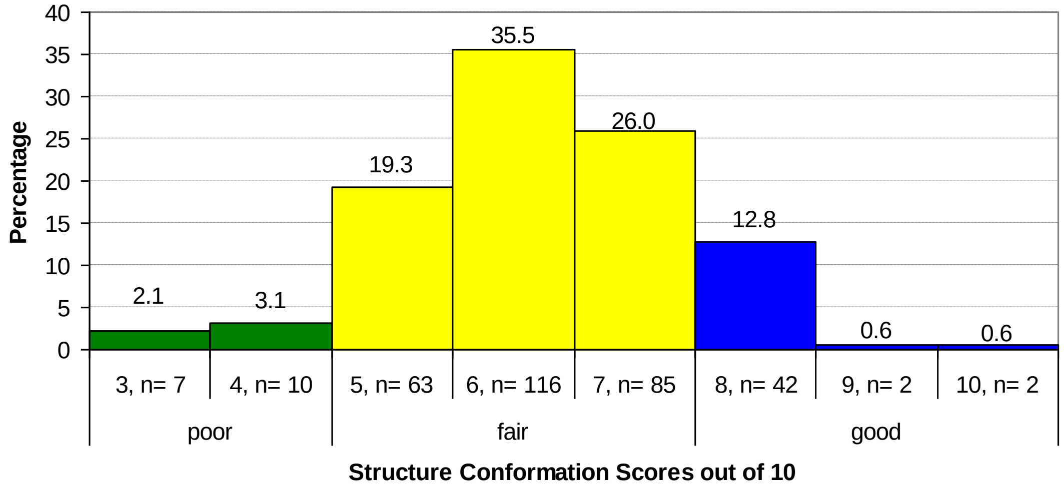


Figure 39: Distribution of Scores out of 10 for Structure of Conformation (n = 327)

Walk scores in this population were mostly fair (5-7), with 77.3% of horses falling into this range of scores. A very small percentage of horses scored poor marks (4) representing only 1.7% of the population. Some 20.8% of horses scored well (8-10), as shown in Figure 40.

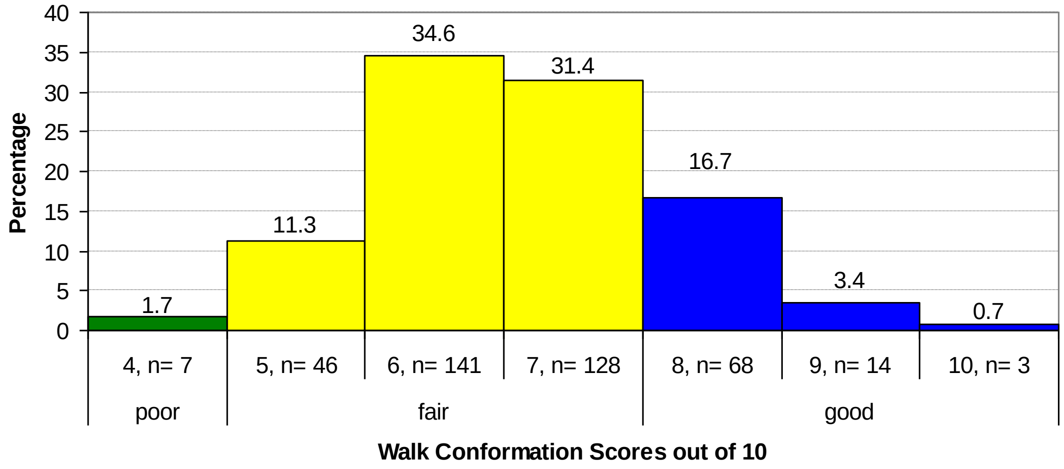


Figure 40: Distribution of Scores out of 10 for Walk (n = 407)

The distribution of scores for trot, are depicted in Figure 41 below. Again most horses (79.5%) were in the fair range (5-7) of scores with slightly more horses (17.3%) scoring good (8-10) compared to horses (3.2%) scoring poor (2, 4).

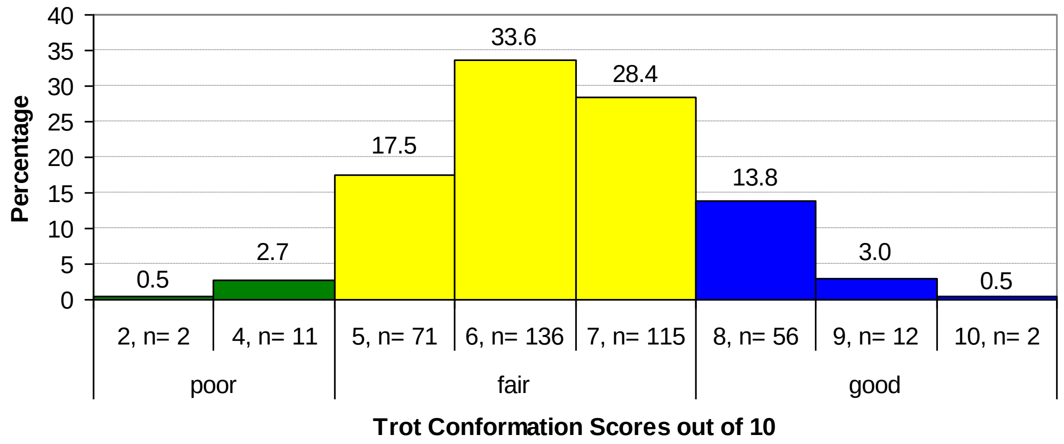


Figure 41: Distribution of Scores out of 10 for Trot (n = 405)

4.3.2 Descriptive Statistics of Linear Traits

Linear traits describe two opposing biological extremes, therefore describing the conformation rather than scoring it. These traits were analysed using descriptive statistics to view the distribution of the population according to the biological extremes of each trait. In the following section average refers to the midpoint between biological extremes. None of these traits were affected by breed type or sire ($p > 0.05$).

Most horses had average head conformation accounting for 67.7% of the population. Similar percentages lie on either biological extreme, with 16.4% having fine/slightly fine heads and 15.8% having plain/slightly plain heads (Figure 42).

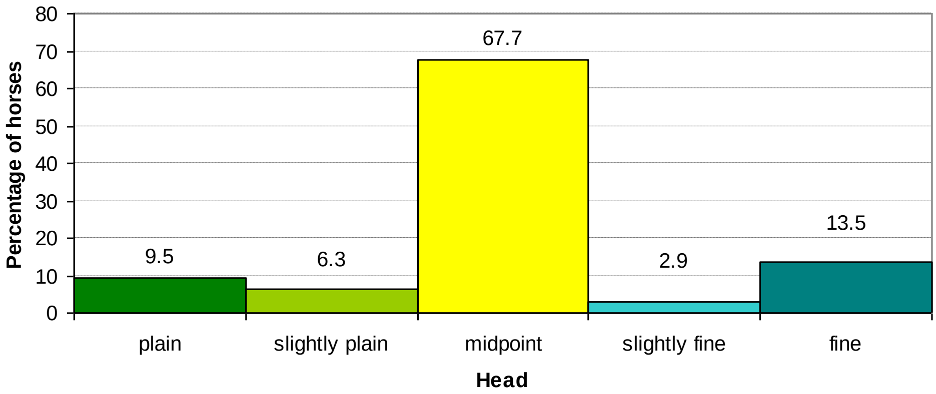


Figure 42: Distribution of Linear Scored Head Conformation (n = 347)

A small percentage of horses had a heavy/slightly heavy or thick head-neck connection (8%) and a higher percentage had a light/slightly light head and neck connnection (18.6%). The largest percentage had average head-neck connections (71.9%), as shown in Figure 43.

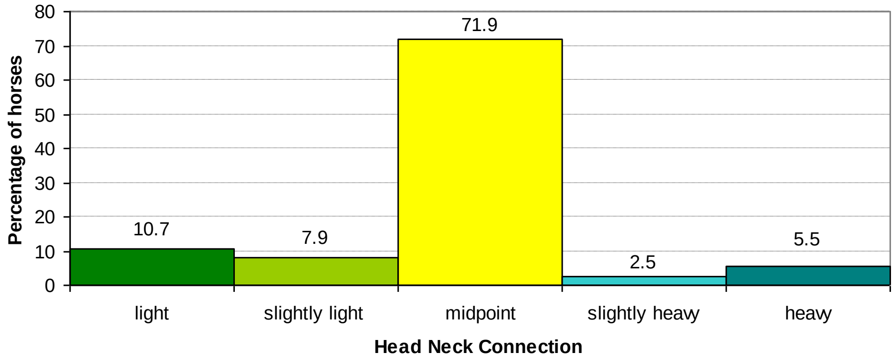


Figure 43: Distribution of Linear Scored Head to Neck Connection (n = 366)

Average neck-body connection was present in the majority of horses, 41.5%. Deep/slightly deep neck body connection was present in 30.7% of horses, while 27.8% of horses had narrow/slightly narrow neck-body connection (Figure 44).

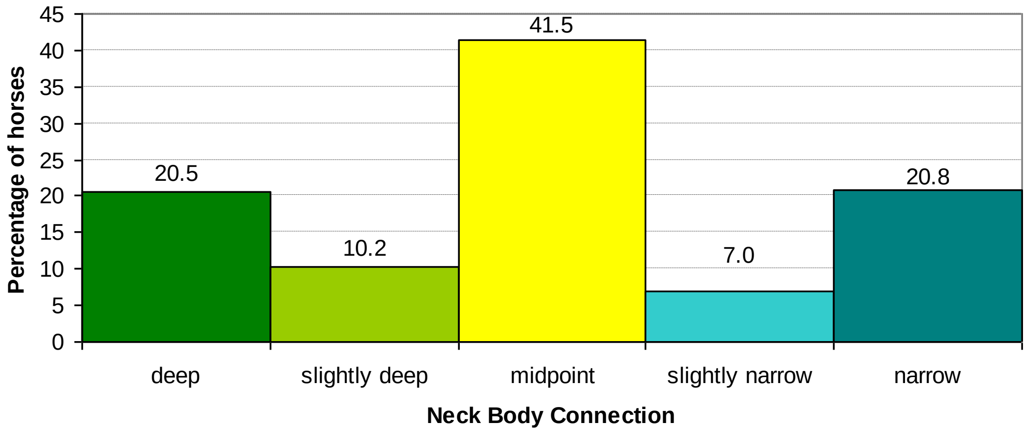


Figure 44: Distribution of Linear Scored Neck to Body Connection (n = 371)

Only a small percentage of horses had a long/slightly long neck (1%). In contrast to that, 19.2% of horses had short/slightly short necks. The largest percentage of horses had average neck length accounting for 79.7% of the population (Figure 45).

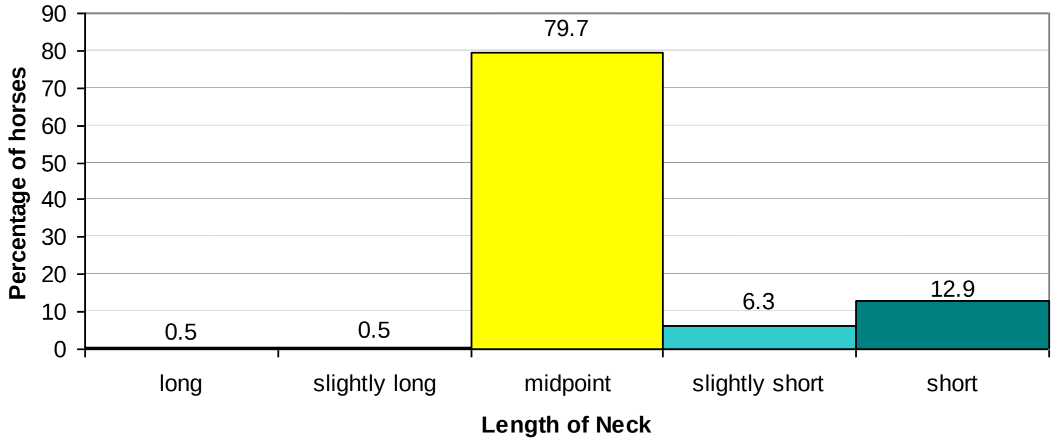


Figure 45: Distribution of Linear Scored Length of Neck Conformation (n = 364)

Just over half of the horses, (58.6%), were found to have average muscling of the neck, while 30.3% of horses displayed a tendency toward poor/slightly poor muscling. The remaining 11.2% of horses were on the heavy/slightly heavy side of muscling of the neck (Figure 46).

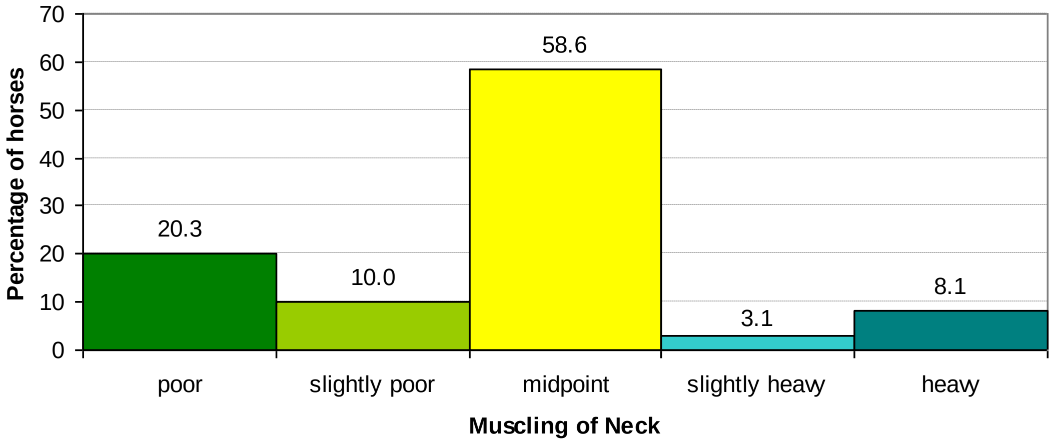


Figure 46: Distribution of Linear Scored Muscling of Neck Conformation (n = 366)

Most horses had average wither conformation, not high or flat withers (77.3%). A minority of horses (5.9%) had flat/slightly flat wither conformation, a larger percentage, (16.9%), displayed the opposite trait of high/slightly high wither conformation (Figure 47).

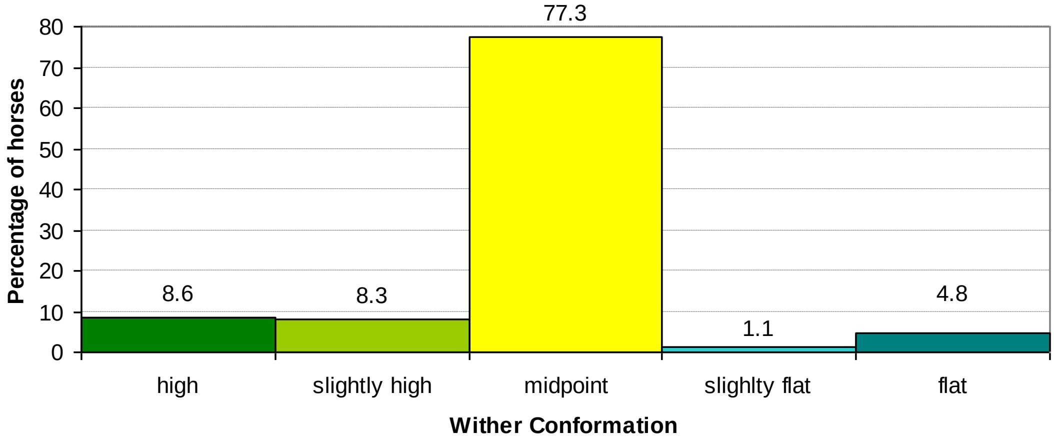


Figure 47: Distribution of Linear Scored Wither Conformation (n = 374)

Approximately half or 46.0% of horses had an average shoulder angle. Similar proportions were observed for both straight/slightly straight and sloping/slightly sloping shoulder angle, with 26.6% and 27.4% respectively (Figure 48).

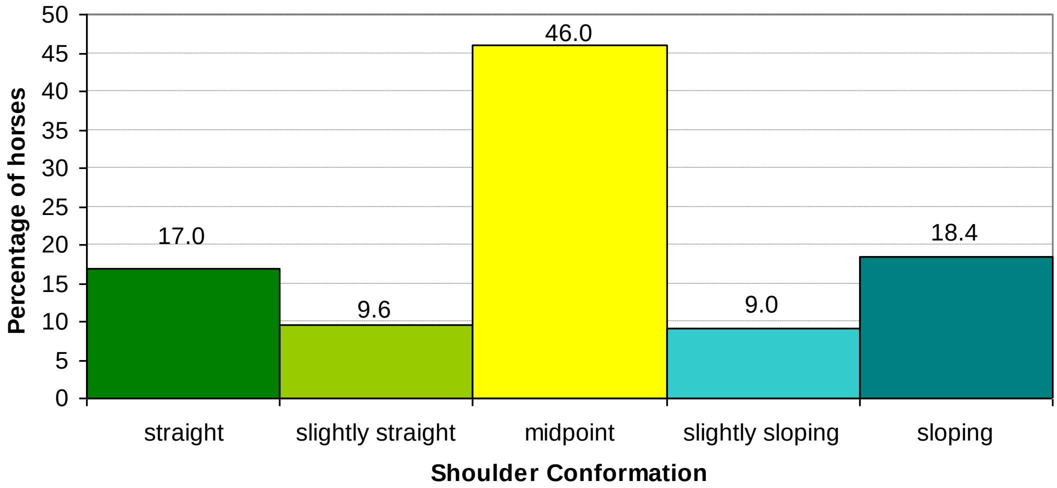


Figure 48: Distribution of Linear Scored Shoulder Conformation (n = 365)

In the sample population, the majority of horses were observed to have average knee conformation (71.5%). A minority (10.1%) presented with forward/slightly forward or over the knee conformation. A slightly higher proportion were back/slightly back at the knee (18.5%), as shown in Figure 49.

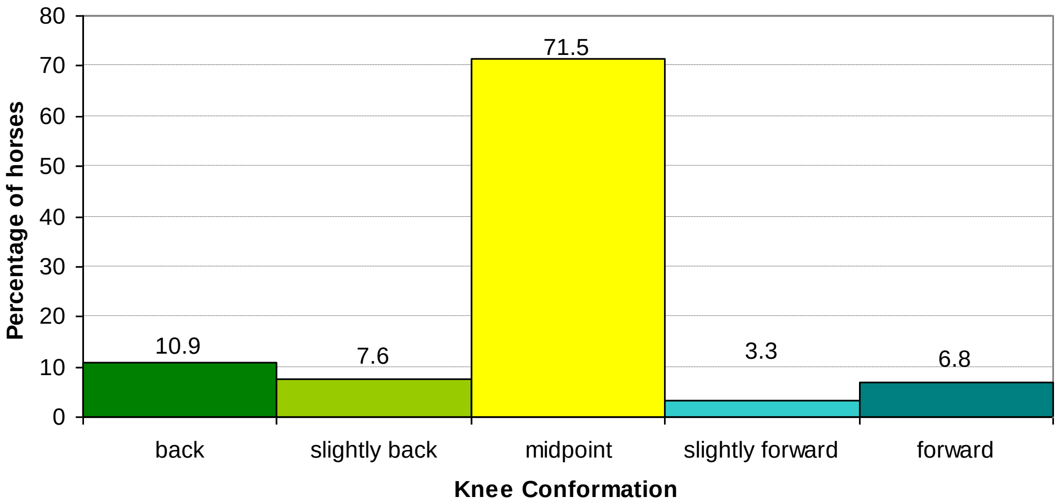


Figure 49: Distribution of Linear Scored Knee Conformation (n = 368)

A very high percentage (83.4%) of horses had average pastern conformation. There was an even distribution on either side of the biological average, with 9.1% having weak/slightly weak pastern conformation and 7.5% of horses had upright/slightly upright pasterns (Figure 50).

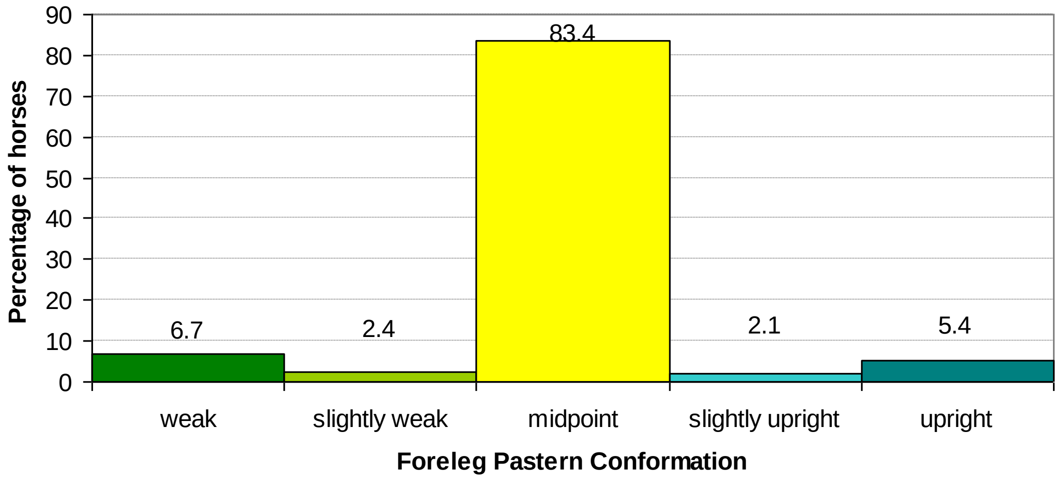


Figure 50: Distribution of Linear Scored Foreleg Pastern Conformation (n = 373)

The largest proportion of horses had average cannon bone circumference (63.5%). A total of 29.0% had light/slightly light bone circumference and a small proportion presented with strong/slightly strong bone, 7.4% (Figure 51).

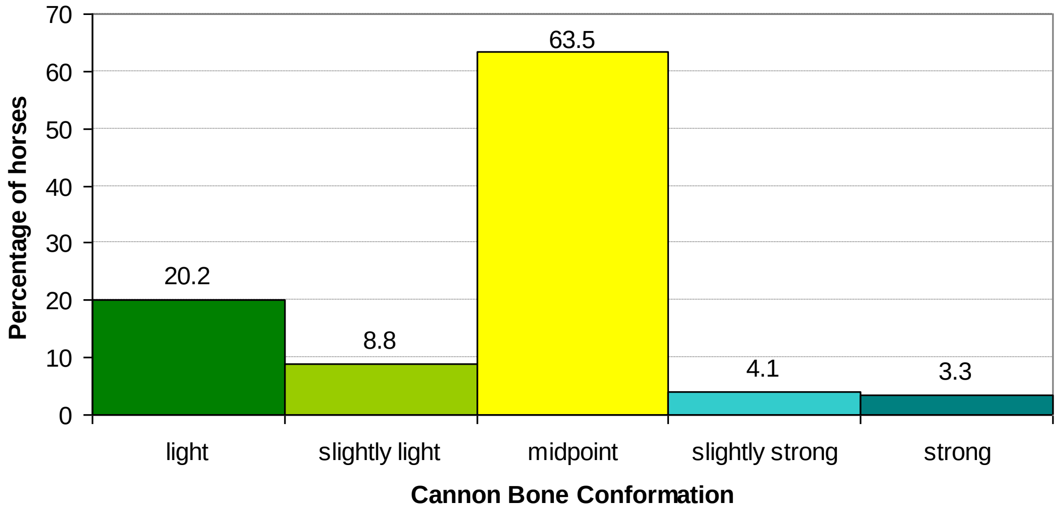


Figure 51: Distribution of Linear Scored Cannon Bone Conformation (n = 362)

The majority of horses had average size gaskin conformation (81.6%). A slightly higher percentage of horses had weak/slightly weak gaskins (14.4%), compared to the percentage of horses with strong/slightly strong gaskins (4.1%), as presented in Figure 52.

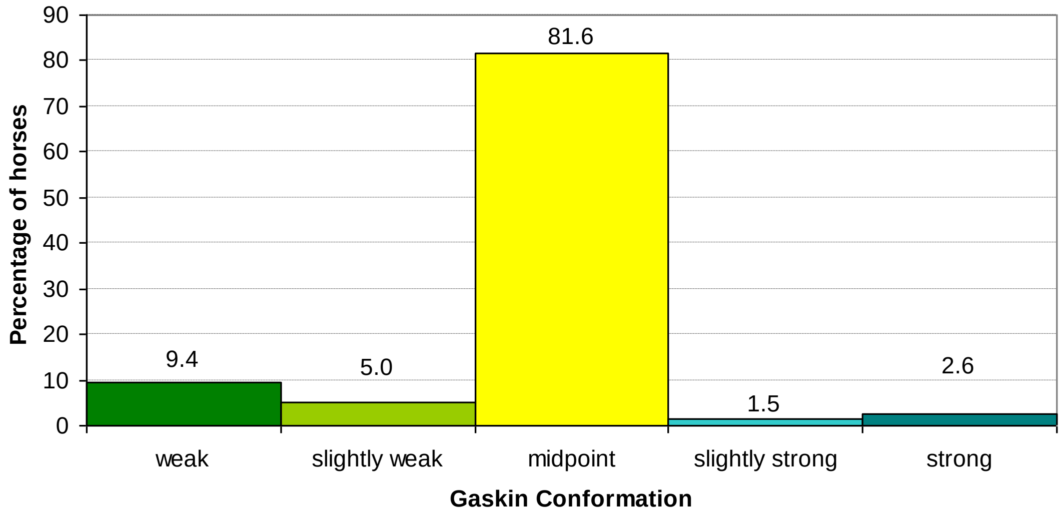


Figure 52: Distribution of Linear Scored Gaskin Conformation (n = 342)

Figure 53 shows that the biggest proportion of horses had average muscularity of quarters (73.8%). The proportion of horses with poor/slightly poor muscularity of quarters (13.5%) was similar to the proportion of horses with strong/slightly strong muscularity of the quarters (12.7%).

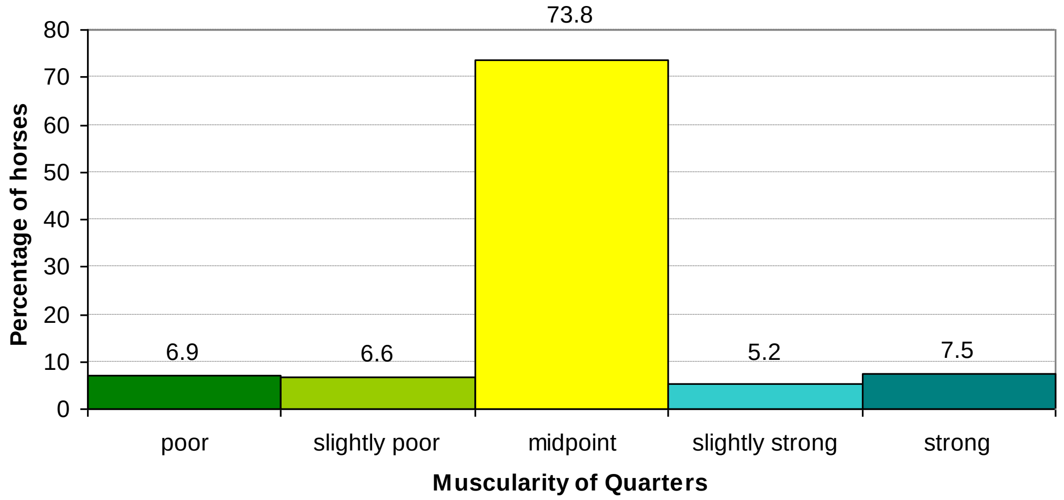


Figure 53: Distribution of Linear Scored Muscularity of Quarters (n = 362)

Just over half of horses had average hock conformation (55.2%). A proportion of 32.4% of the population sample, had sickle/slightly sickle conformation of the hock (Figure 54). A smaller fraction presented with straight/slightly straight hock conformation (12.4%).

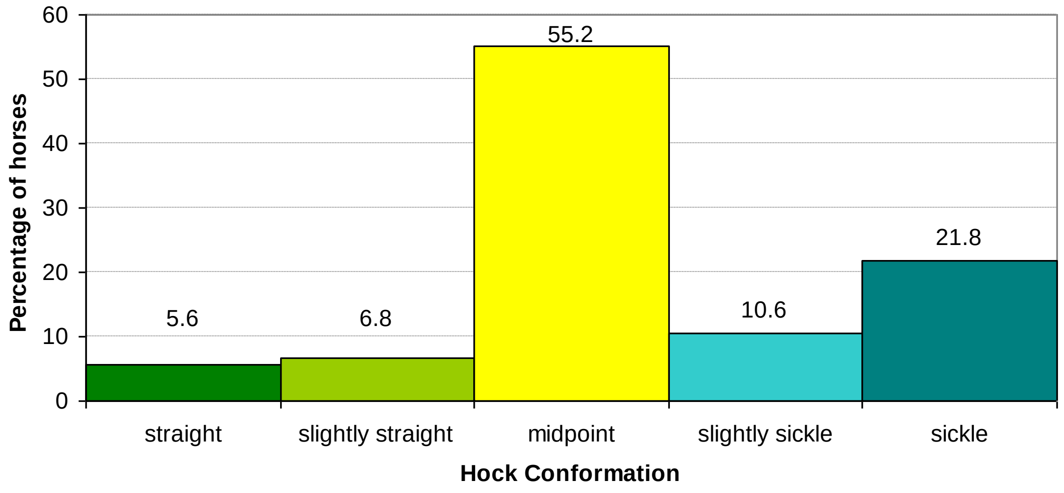


Figure 54: Distribution of Linear Scored Hock Conformation (n = 339)

Figure 55 shows that 83.8% of horses had average hoof width. A very small percentage presented with narrow/slightly narrow hoofs (3.6%), while 12.6% had wide/slightly wide hoofs.

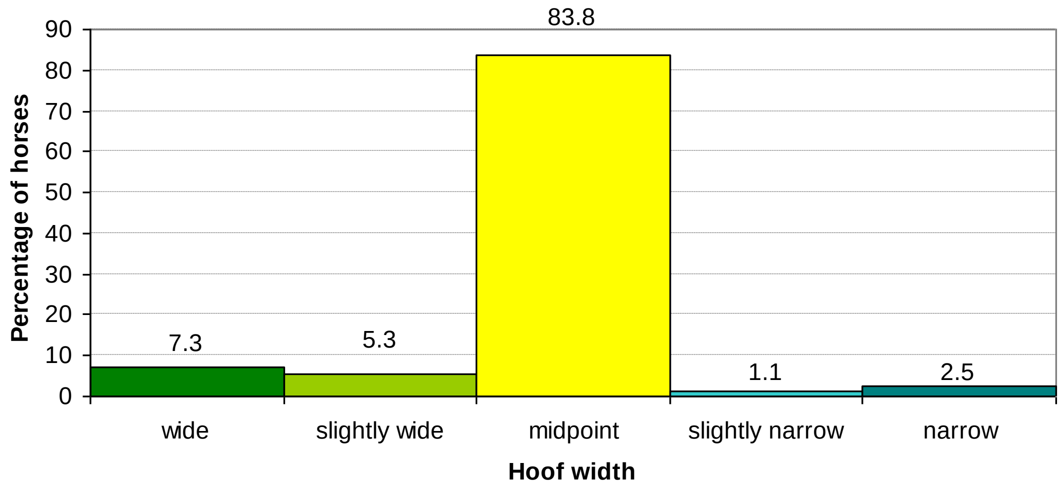


Figure 55: Distribution of Linear Scored Hoof Width (n = 358)

In this population, the majority of horses had average heel height (75.1%). A small proportion (6.2%) of horses had higher/slightly higher than average heels, whilst a higher percentage (18.6%) of horses presented with lower/slightly lower than average heels (Figure 56).

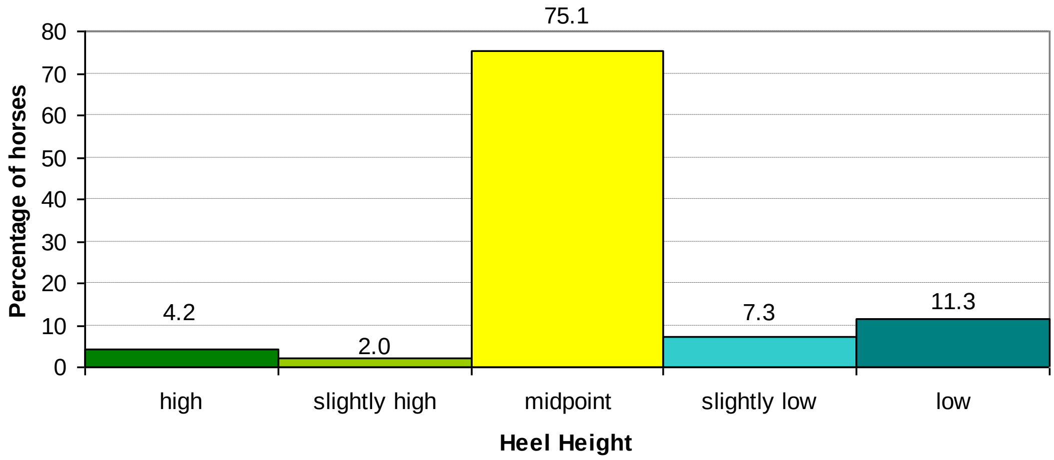


Figure 56: Distribution of Linear Scored Heel Height (n = 354)

The majority of horses had an average length of back (63.2%), as shown in Figure 57. Short/slightly short back length is a biological extreme and 10.0% of horses were on that side of the scale. A higher proportion of 26.8% of the population had a longer/slightly longer back length than average.

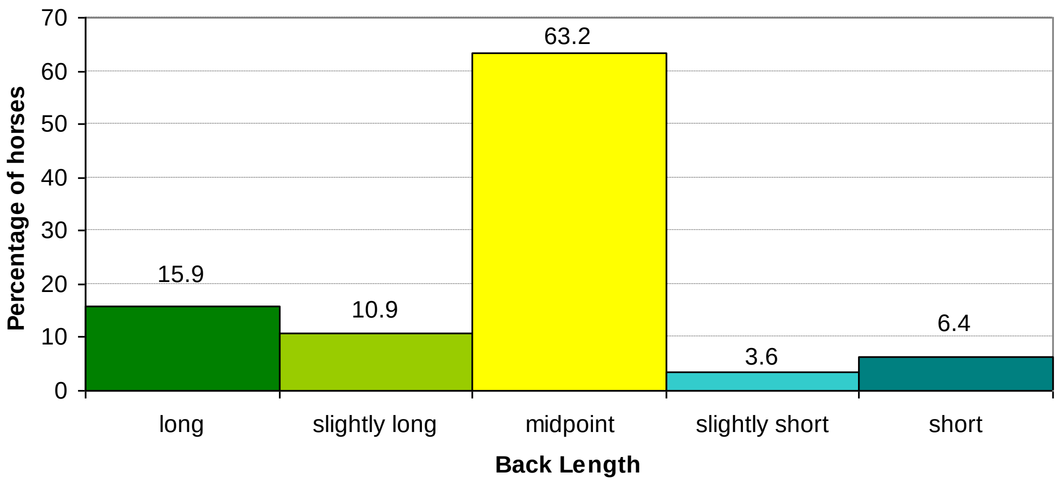


Figure 57: Distribution of Linear Scored Back Length (n = 359)

Croup conformation can be flat/slightly flat and in this population 5.6% of horses had this conformation trait. On the other end of the scale, croup conformation is sloping/slightly sloping, a proportion of 20.6% of horses fell into this category. The largest proportion of horses (73.7%) was classified into an average croup conformation (Figure 58).

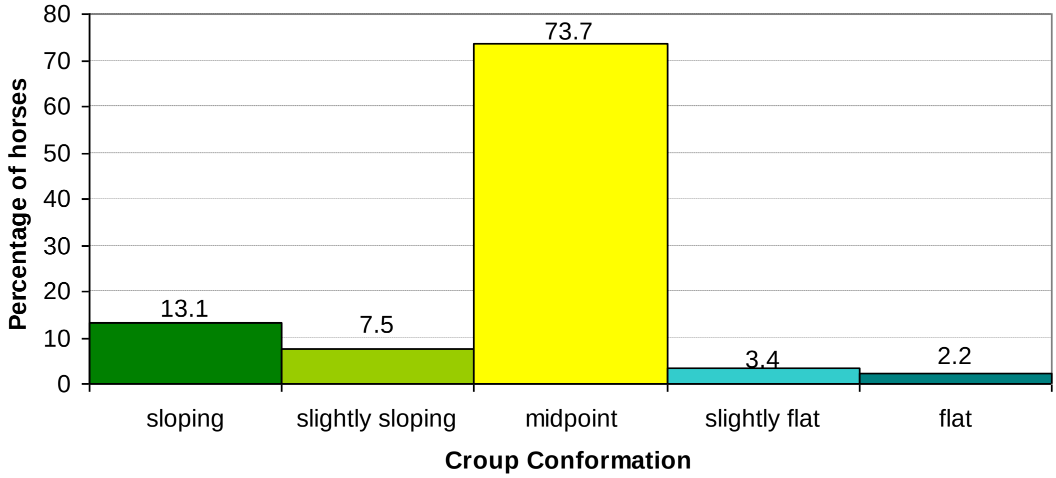


Figure 58: Distribution of Linear Scored Croup Conformation (n = 358)

With respect to muscling of the loin, the distribution of horses in this trait deviates from previous examples. The majority of horses in this population had weak/slightly weak loin muscling with 54.8% recorded as less than the average. Only a small percentage (9.3%) of the population presented with strong/slightly strong loin musculature. A total of 36.0% were observed in what was perceived as average loin muscling (Figure 59).

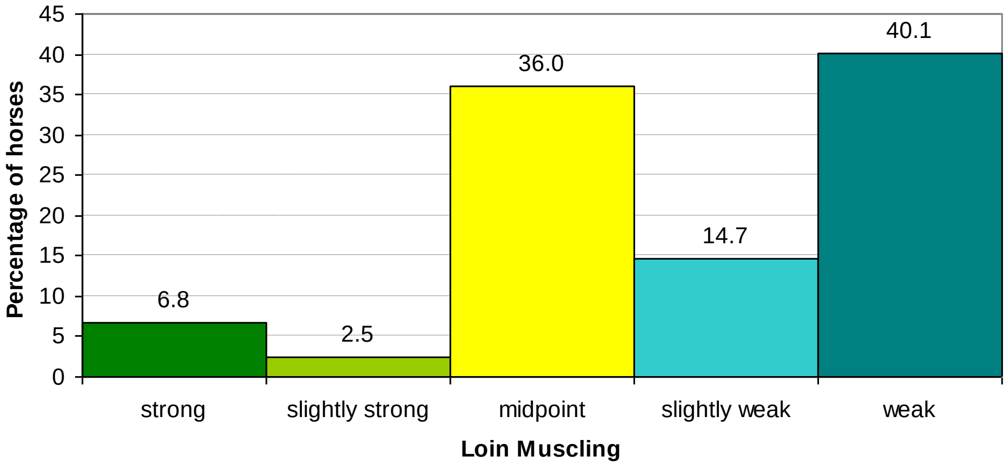


Figure 59: Distribution of Linear Scored Loin Muscling (n = 367)

As shown in Figure 60, just over half of the horses in this study (53.6%) were average in their frame (53.6%). Over a third of the population were rectangular/slightly rectangular in shape (34.9%), while a smaller percentage (11.6%) was squarer/slightly squarer in shape.

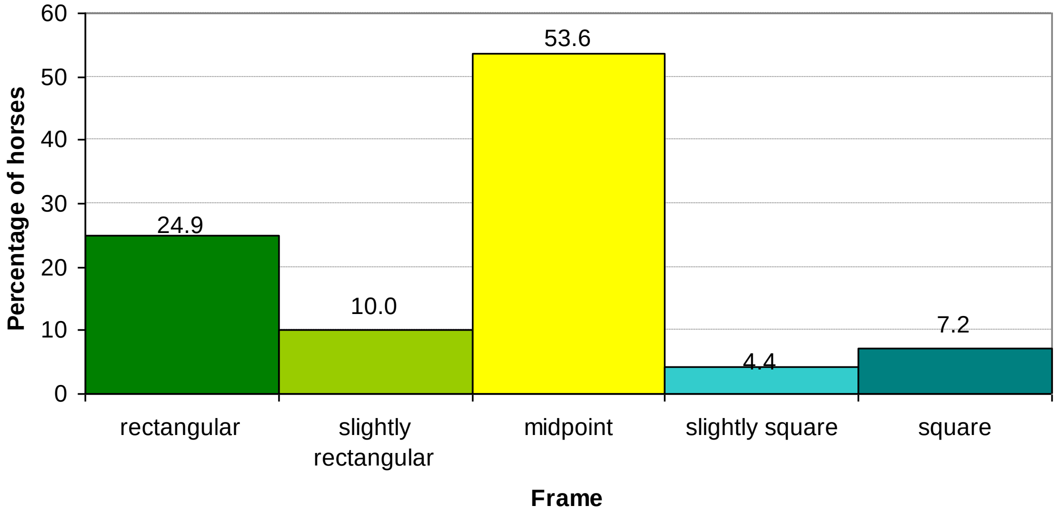


Figure 60: Distribution of Linear Scored Frame (n = 321)

Stride length at the walk is often used to assess the quality of movement. In this population, 9.2% of the population were assessed to have a short/slightly short stride length. A higher percentage (32.3%) of horses, almost a third of the population were found to have longer/slightly longer stride lengths than average. The highest proportion of horses (58.4%) had average stride length (Figure 61).

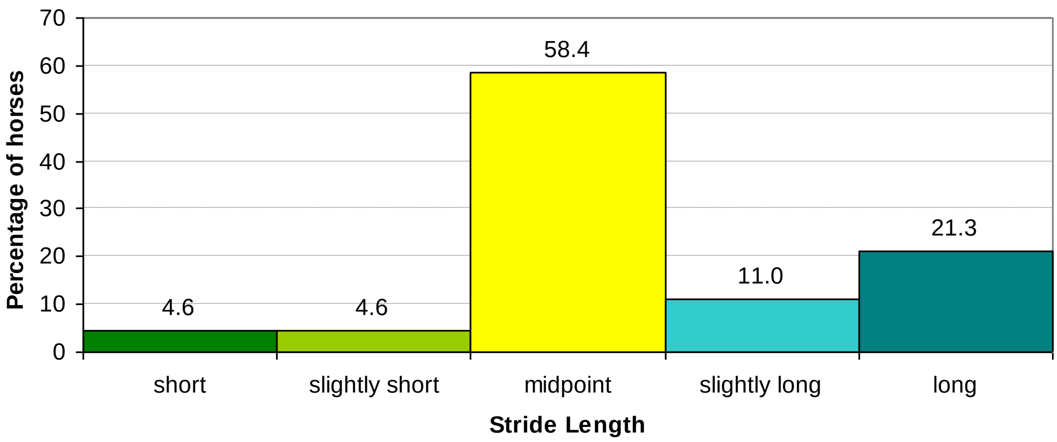


Figure 61: Distribution of Linear Scored Stride Length in the Walk (n = 409)

Deviations in the walk were assessed; the results show that almost two thirds of horses are in the average range (67.1%), which is the least amount of deviation shown at walk. Of the horses in the population 10.4% deviated from the average by toeing in/slightly toeing in. The opposite of toeing in is toeing out/slightly toeing out and a slightly higher proportion of 22.5% were observed to be on this side of the scale (Figure 62).

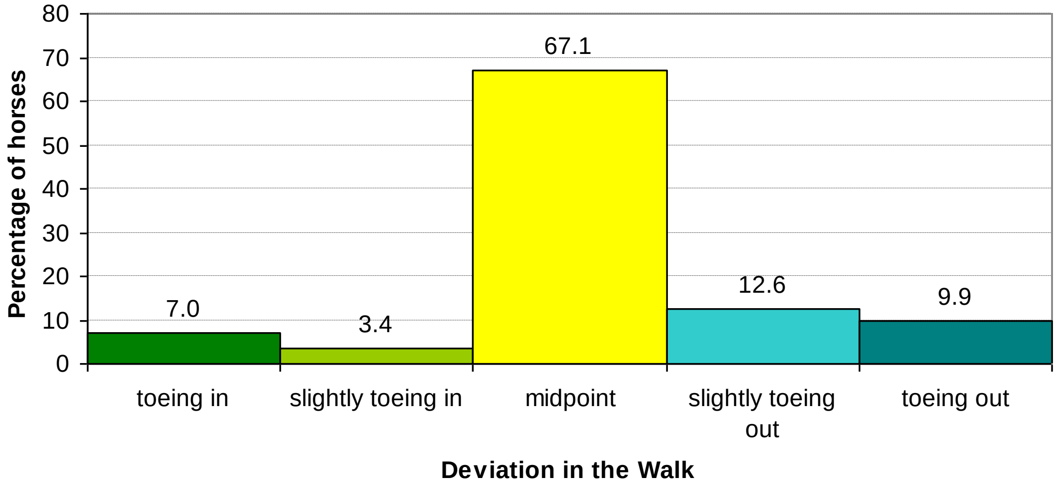
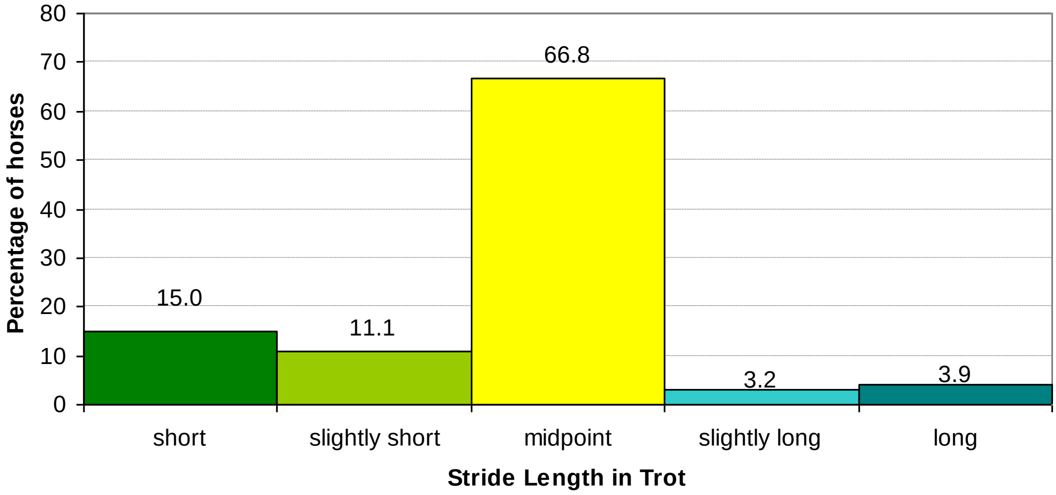


Figure 62: Distribution of Linear Scored Deviation in the Walk (n = 413)

The majority of horses had an average stride length at trot (66.8%); 26.1% had a shortened/slightly shortened stride length in comparison to the average. Only a minor percentage (7.1%) of horses was observed to have a longer/slightly longer stride length at trot (Figure 63).



F

igure 63: Distribution of Linear Scored Stride Length in the Trot (n = 407)

Over half of the population (55.6%) had average impulsion at the trot (55.6%). Weak/slightly weak impulsion was observed in 28.8% of horses, while 15.6% had more powerful/slightly more powerful impulsion in the trot than average (Figure 64).

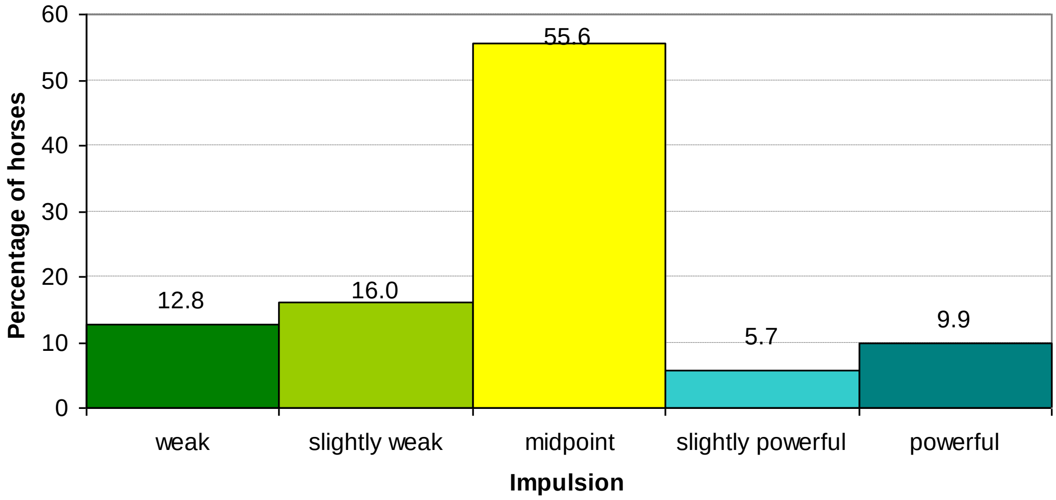


Figure 64: Distribution of Linear Scored Impulsion (n = 405)

In regard to deviation at the trot, 21.9% of the horses examined dished/slightly dished. A lower percentage (13.5%) was observed to plait/slightly plait at the trot. Most of the horses displayed very little deviation at the trot (64.6%), as shown in Figure 65.

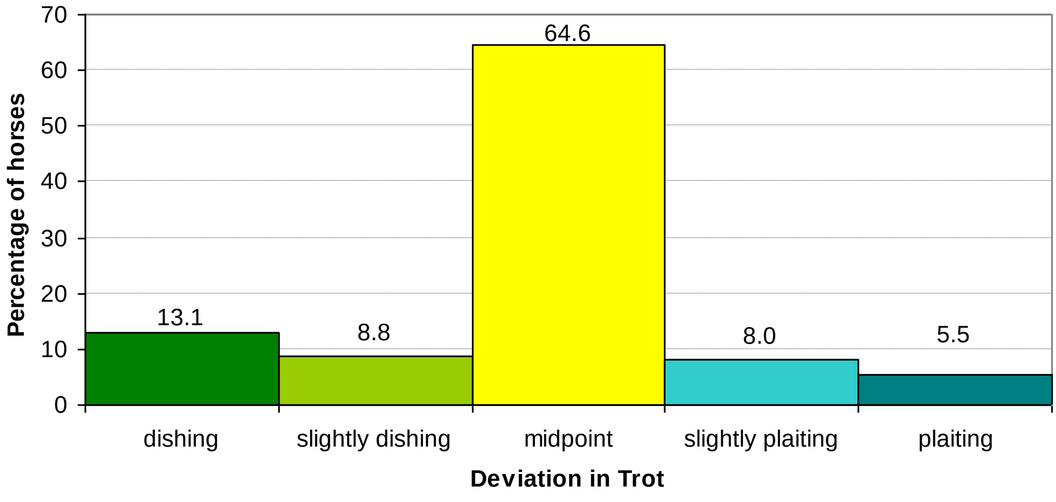


Figure 65: Distribution of Linear Scored Deviation in the Trot (n = 398)

4.4 Summary of Interview Descriptive Traits and Descriptive Scored Traits of the Study Population

In order to compare whether the conformation of horses widely used for eventing were consistent with the conformational qualities deemed necessary by top level riders, a comparison of the informed opinions of four star riders on ideal conformation traits of event horses and traits observed in the horse population of this study was carried out. Results for each of the traits of descriptive nature are shown in the Figures below. Average refers to the midpoint between the two biological extremes in the Figures below.

Half of the competitors favoured an average head-neck connection, and the majority of the horses in the study sample were observed to conform to this ideal. Almost as many competitors favoured a light or lighter head-neck connection, while a minority of horses were observed with this type of head-neck connection. However, the general trend is very similar (Figure 66).

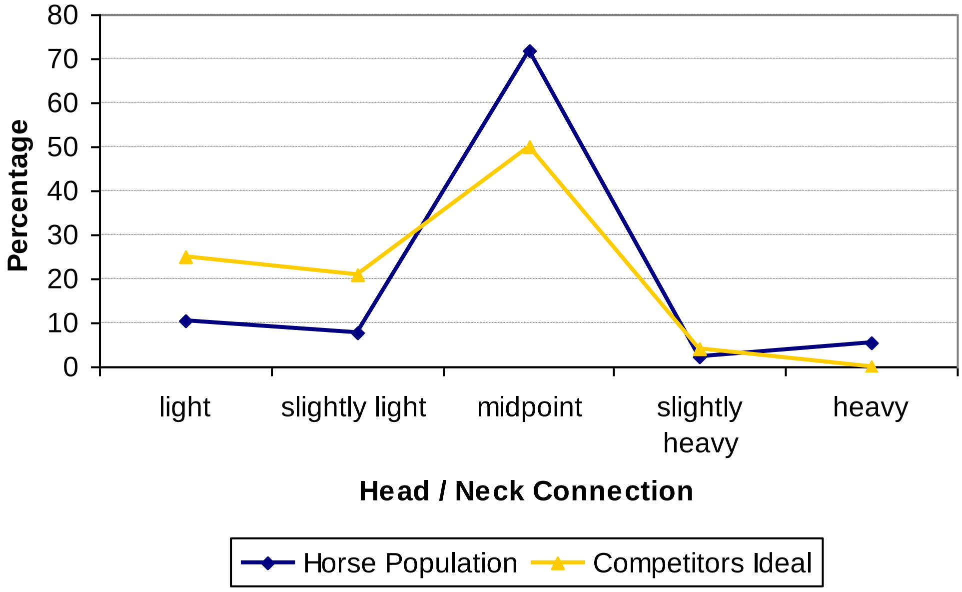


Figure 66: Comparison of Head-Neck Connection in the Study Population with Competitors Opinions on Ideal

The majority of competitors favoured a slightly narrow or narrow neck-body connection. In comparison just over a quarter of horses were observed with slightly narrow to narrow neck-body connections, with the majority of horses having average neck-body connections (Figure 67).

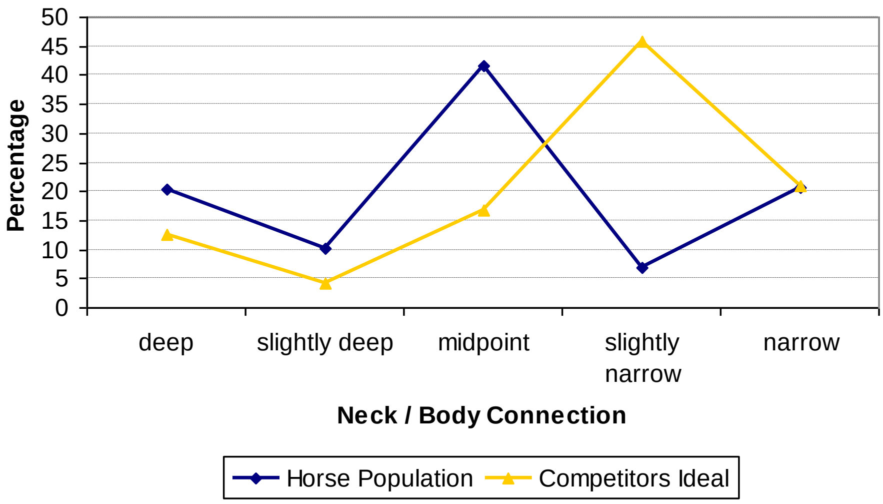


Figure 67: Comparison of Neck-Body Connection in the Study Population with Competitors Opinions on Ideal

As shown in Figure 68, the majority of competitors deemed average neck length to be ideal and the majority of horses in the study population conformed to this ideal. A smaller percentage preferred slightly long necks, less than 1% of horses had long necks. A minority of horses had short necks, none of the competitors responded that short neck length was suitable conformation for eventing. Patterns of both are very similar.

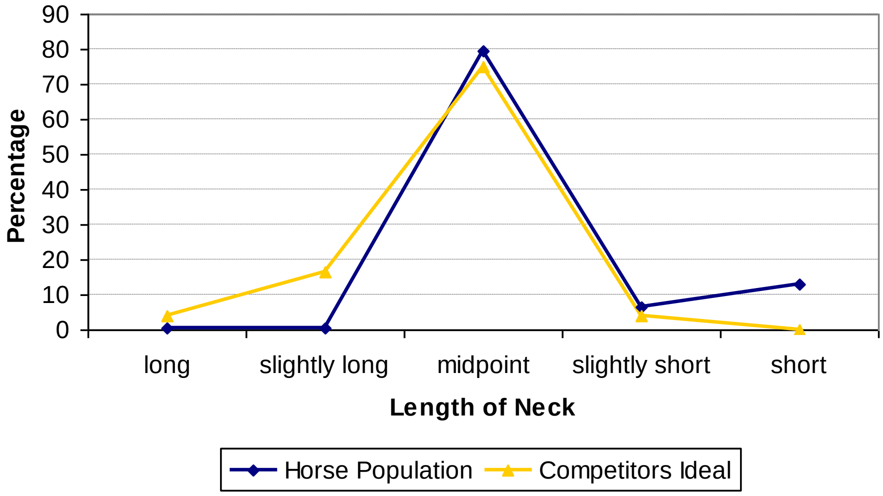


Figure 68: Comparison of Length of Neck in the Study Population with Competitors Opinions on Ideal

Muscling of neck as shown in Figure 69 showed different distributions in comparison. Competitors favoured slightly heavy to heavy neck muscling. The majority of the population of horses in the study had average muscling of the neck and a minority were observed with slightly poor to poor muscling. A small percentage of horses fell into the slightly heavy to heavy category. Trends are distinctly different between both.

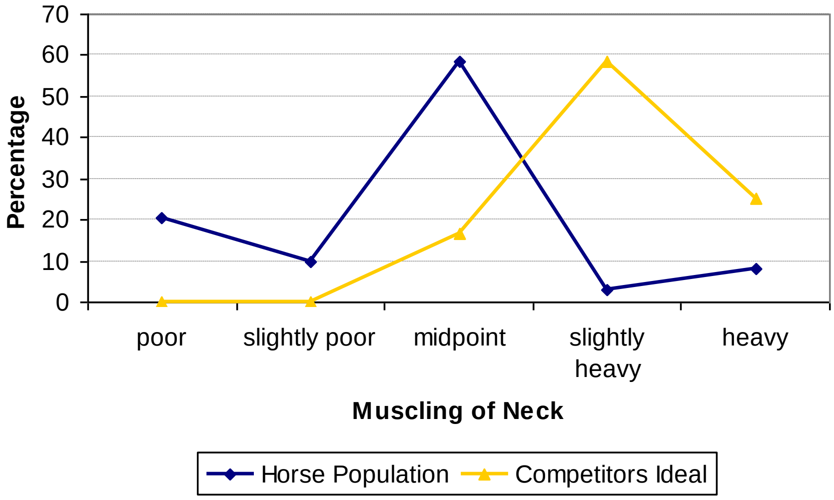


Figure 69: Comparison of Muscling of Neck in the Study Population with Competitors Opinions on Ideal

Comparison of ideal wither conformation with wither conformation observed in the study population were similar. Competitors mostly desired average wither height and the majority of horses in the sample population were observed to have average wither height. A minority of competitors favoured slightly high withers and some horses displayed this trait. Patterns observed are very similar (Figure 70).

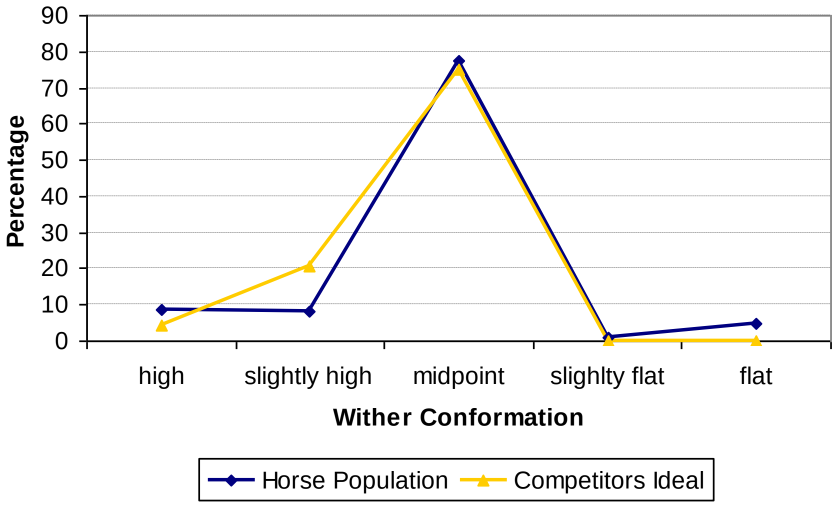


Figure 70: Comparison of Wither Conformation in the Study Population with Competitors Opinions on Ideal

The shoulder conformation preferred by most competitors was sloping, and a quarter of competitors favoured slightly sloping or average shoulder inclination. None of the competitors favoured straight shoulders. The population of horses followed a different trend, with the majority of horses falling into the average category and similar percentages had slightly straight to straight shoulders and slightly sloping to sloping (Figure 71).

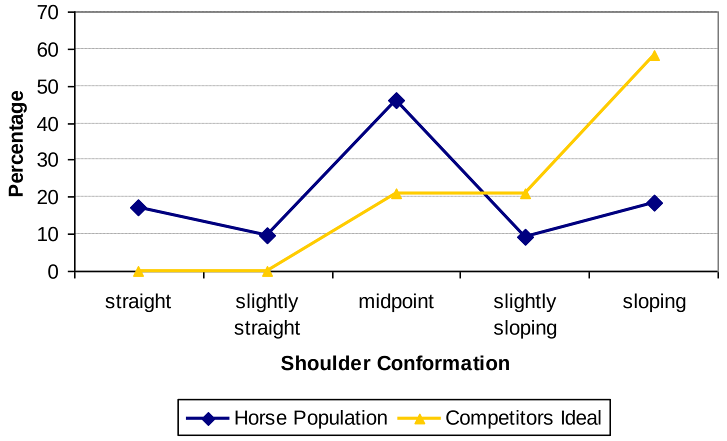


Figure 71: Comparison of Shoulder Conformation in the Study Population with Competitors Opinions on Ideal

The majority of riders favoured average knee conformation, at the midpoint between biological extremes, and the majority of horses in the population sample were observed to conform to this. The remaining riders favoured a slightly forward conformation of the knee, with none of the competitors choosing the remaining categories. A bigger minority of horses were observed with back or slightly back knee conformation than slightly forward or forward knee conformation. Trends are largely the same (Figure 72).

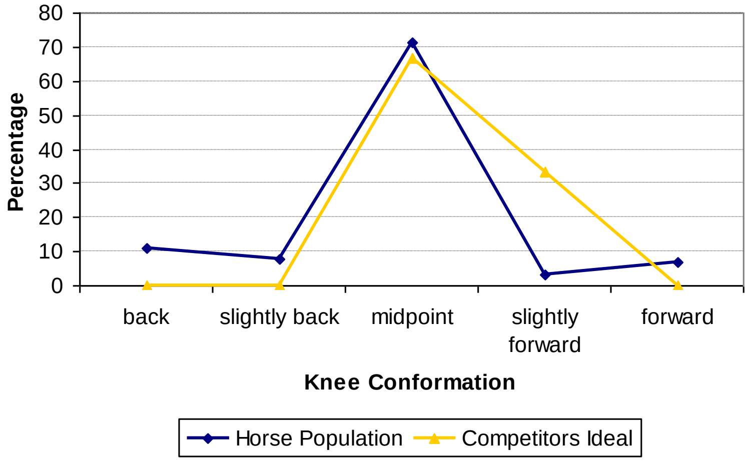


Figure 72: Comparison of Knee Conformation in the Study Population with Competitors Opinions on Ideal

In Figure 73, pastern conformation ideal was average, at the midpoint between extremes, and a minority favoured slightly upright / short pasterns, which only a small percentage of horses were observed to have. Most horses had average pastern conformation and only small percentages had weak / long or upright / short pasterns. Trends are similar in the main two findings in the field.

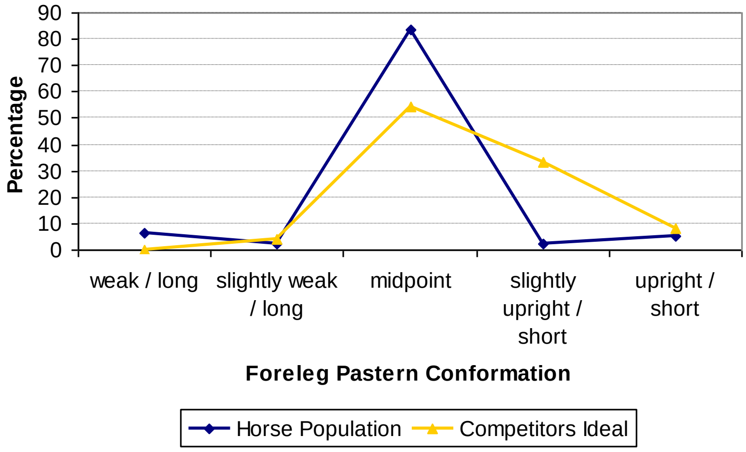


Figure 73: Comparison of Foreleg Pastern Conformation in the Study Population with Competitors Opinions on Ideal

Cannon bone conformation was favoured to be average, at the midpoint, or slightly strong, a minority of competitors preferred slightly light or strong. Preferences were more individual with not one obvious reference indicated. The majority of horses had average cannon bone conformation with a higher percentage having slightly light to light bone conformation than slightly strong to strong. None of the competitors selected light cannon bone conformation as ideal (Figure 74).

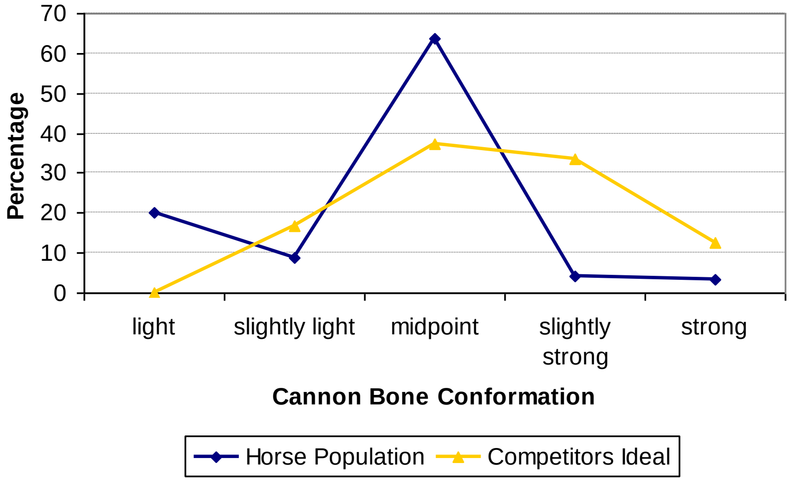


Figure 74: Comparison of Cannon Bone Conformation in the Study Population with Competitors Opinions on Ideal

Comparison of opinions on gaskin conformation and observed gaskin conformation differed greatly. Strong gaskin conformation is preferred to any other category and some competitors favoured average or slightly strong gaskin conformation. The majority of horses in this population had average gaskin conformation and a smaller percentage of horses had weak or slightly weak gaskins and slightly strong or strong gaskin conformation. None of the competitors favoured weak or slightly weak gaskins (Figure 75).

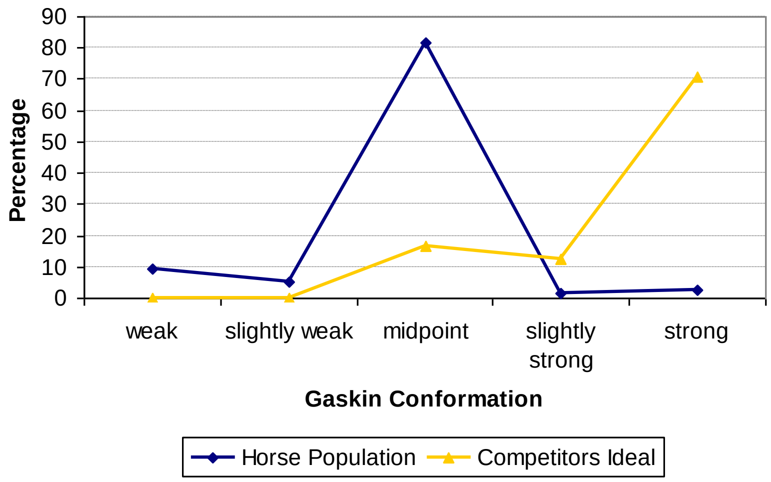


Figure 75: Comparison of Gaskin Conformation in the Study Population with Competitors Opinions on Ideal

The majority of riders preferred slightly strong or strong quarter muscling, with only a minority of horses showing this trait. The majority of horses had average quarter muscling. None of the competitors favoured poor or slightly poor muscling. Some horses were observed in this category. Patterns of observed and desired traits are very different (Figure 76).

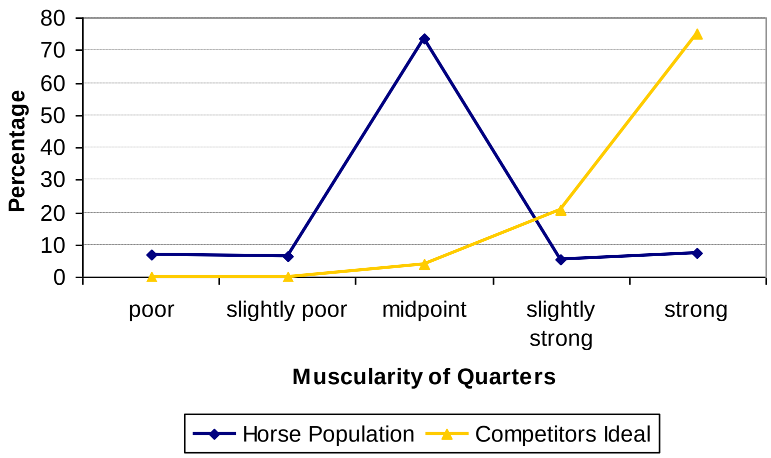


Figure 76: Comparison of Muscularity of Quarters in the Study Population with Competitors Opinions on Ideal

In the opinion of the competitors average hock stance is preferred and a smaller percentage favoured a slightly sickle hock stance. None of the competitors selected any of the other categories. The majority of horses in the population had average hock stance with some horses having slightly sickle hocks and a bigger percentage of horses with sickle hocks. Some horses were observed with straight hocks (Figure 77).

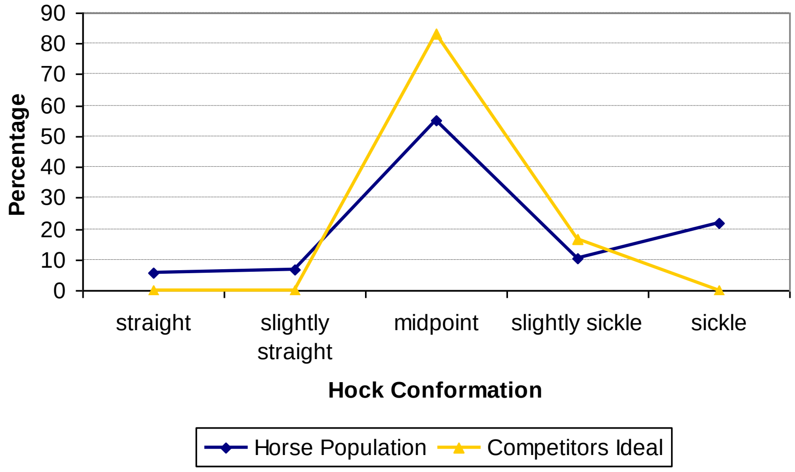


Figure 77: Comparison of Hock Conformation in the Study Population with Competitors Opinions on Ideal

Hoof width was found to be ideal at average by the competitors and the majority of horses were observed to have average hoof width, as shown in Figure 78. Only small percentages of horses were found to deviate from average, similar to the opinion of riders.

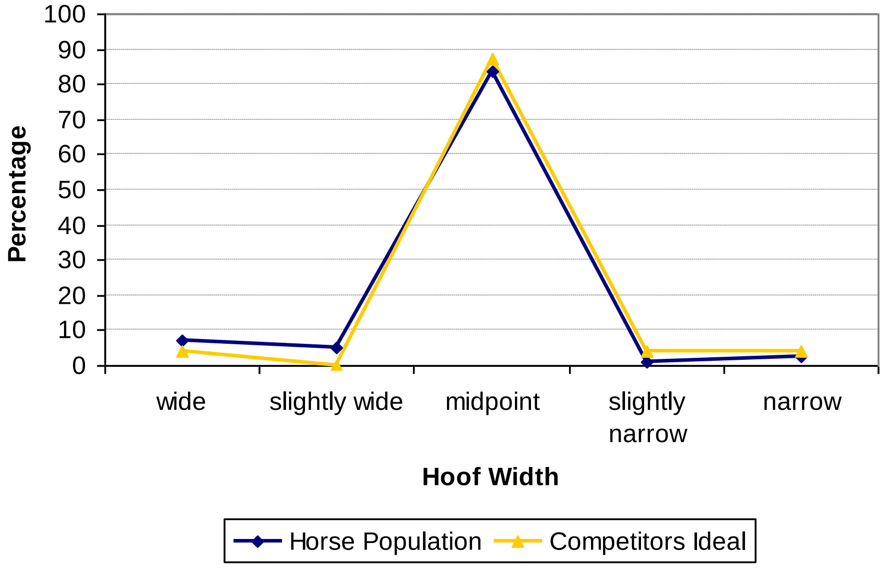


Figure 78: Comparison of Hoof Width in the Study Population with Competitors Opinions on Ideal

Average heel height was favoured by the majority, followed by slightly high heel height and a minority of competitors preferred high heels. Most horses had average heel height. A smaller percentage had slightly low to low heels, which was not favoured by any of the competitors. Only a small percentage of horses had slightly high to high heels (Figure 79).

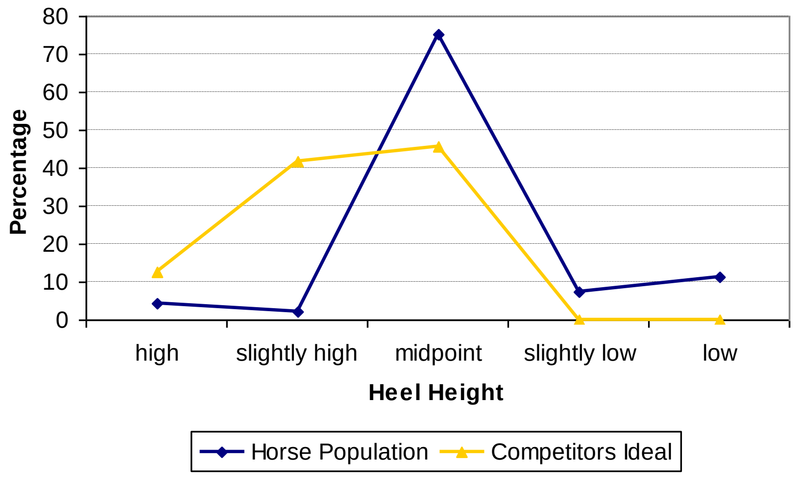


Figure 79: Comparison of Heel Height in the Study Population with Competitors Opinions on Ideal

In the competitors opinion the most suitable back length is average length and most horses in the population sample had average length of back. Almost as many competitors favoured back length to be slightly short or short and only a small percentage favoured a slightly long back and none favoured a long back. A minority of horses had slightly long to long backs with a lowest percentage of horses having slightly short to short back lengths (Figure 80).

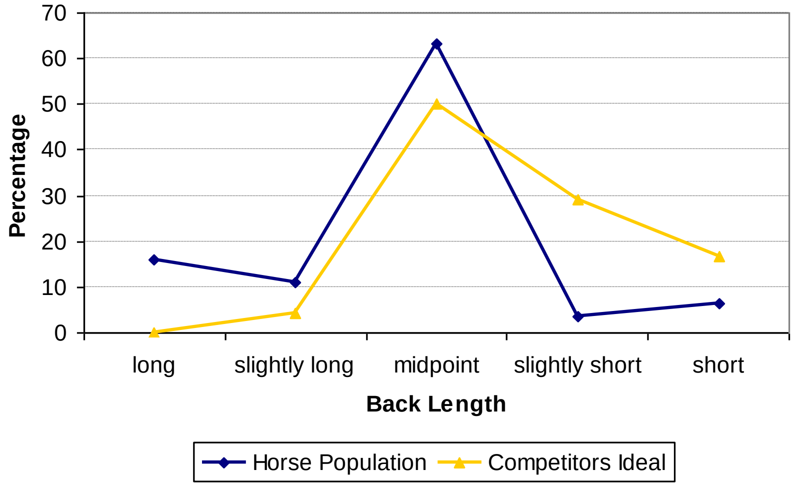


Figure 80: Comparison of Back Length in the Study Population with Competitors Opinions on Ideal

The slope of the croup was preferred to be in between sloping and flat by the majority of competitors. Another high percentage of competitors favoured slightly sloping to sloping croup, with only a small percentage in favour of slightly flat to flat croups. Horses had average croup slopes for the majority of the study population with small percentages of slightly sloping to sloping croups. Similar to preferences of riders only a small percentage had flat croups (Figure 81).

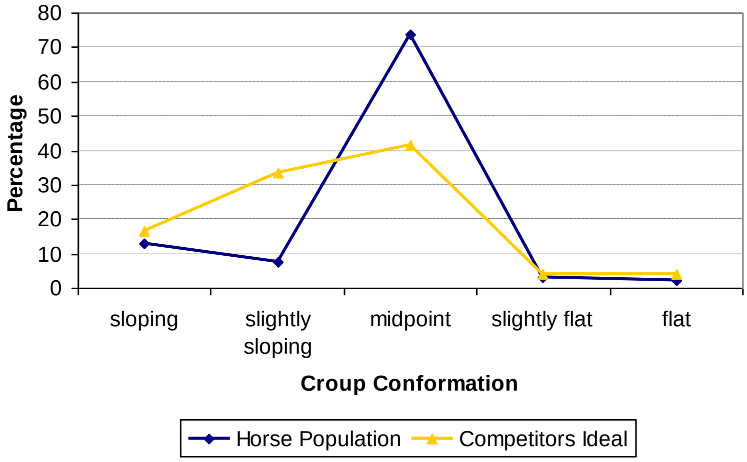


Figure 81: Comparison of Croup Conformation in the Study Population with Competitors Opinions on Ideal

Loin muscling showed opposing trends in Figure 82, riders favoured strong loin muscling and some favoured slightly strong to average muscling and only a small percentage favoured slightly weak muscling of the loin. The majority of horses had weak loin muscling, followed by average and slightly weak. Only a small percentage had slightly strong to strong loin muscling. Patterns observed were very different to those desired by riders.

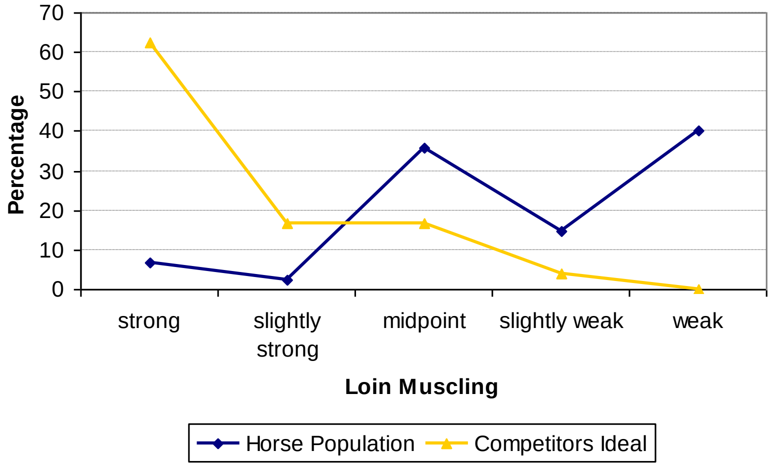


Figure 82: Comparison of Loin Muscling in the Study Population with Competitors Opinions on Ideal

Similar percentages of competitors preferred an average framed horse or slightly square horse, both accounting for the majority of opinions. The remaining competitors favoured slightly rectangular or square horses. The majority of horses evaluated had average frame proportions with almost a quarter of horses being rectangular, which was not favoured by any of the competitors. Smaller percentages of animal were in a slightly rectangular, slightly square or square frame (Figure 83).

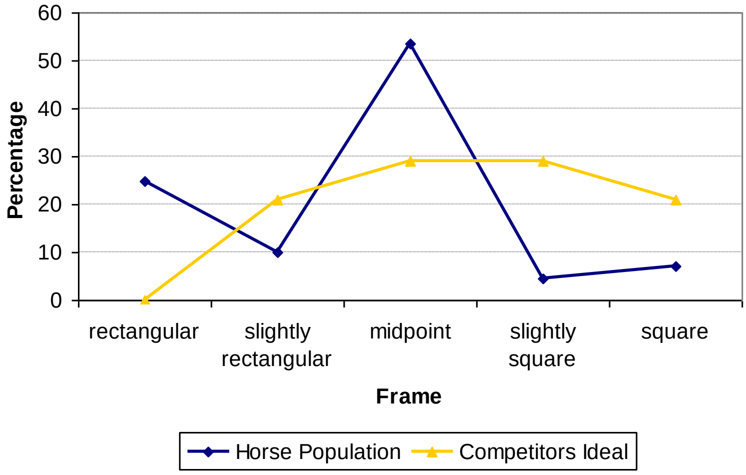


Figure 83: Comparison of Frame in the Study Population with Competitors Opinions on Ideal

At walk long stride length was preferred by the highest percentage of competitors, followed by slightly long and average stride length. None of the competitors favoured slightly short or short stride length. The majority of horses were observed to have average stride lengths with some horses displaying slightly long to long stride lengths. Only a small percentage had stride lengths on the short side. Patterns for observed and desired were very different (Figure 84).

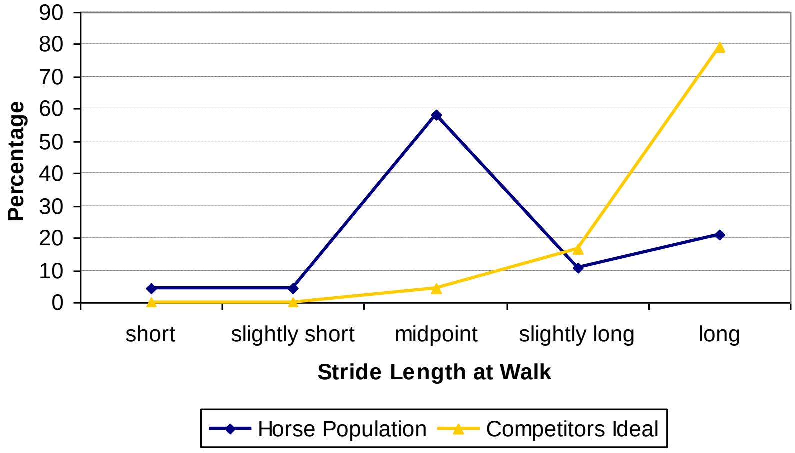


Figure 84: Comparison of Stride Length at Walk in the Study Population with Competitors Opinions on Ideal

All of the competitors favoured no deviation at the walk with the majority of horses observed to fall into this category. A slightly higher percentage of horses were observed to slightly toe out or toe out than the percentage of horses that slightly toe in or toe in (Figure 85).

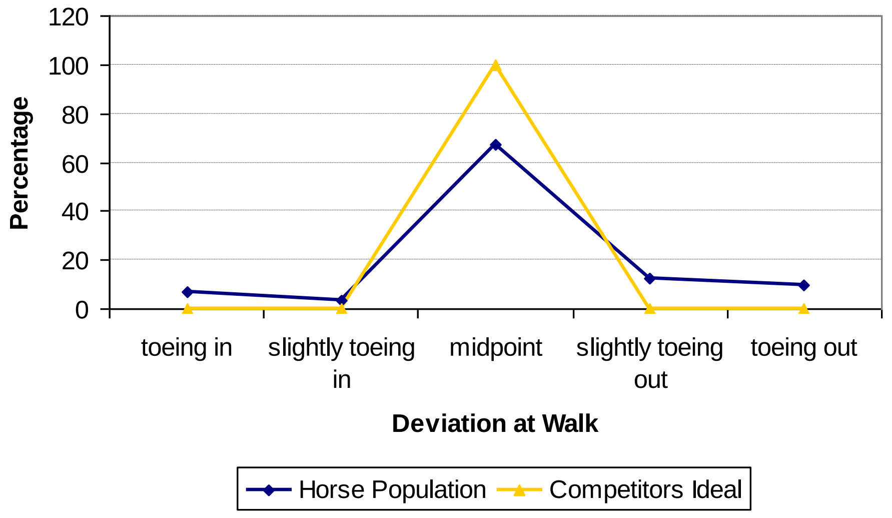


Figure 85: Comparison of Deviation at Walk in the Study Population with Competitors Opinions on Ideal

At trot slightly long and average stride lengths were preferred by the highest percentage of competitors, followed by long stride length. None of the competitors favoured slightly short or short stride length. The majority of horses were observed to have average stride lengths with some horses displaying slightly short to short stride lengths. Only a small percentage had stride lengths on the long side (Figure 86).

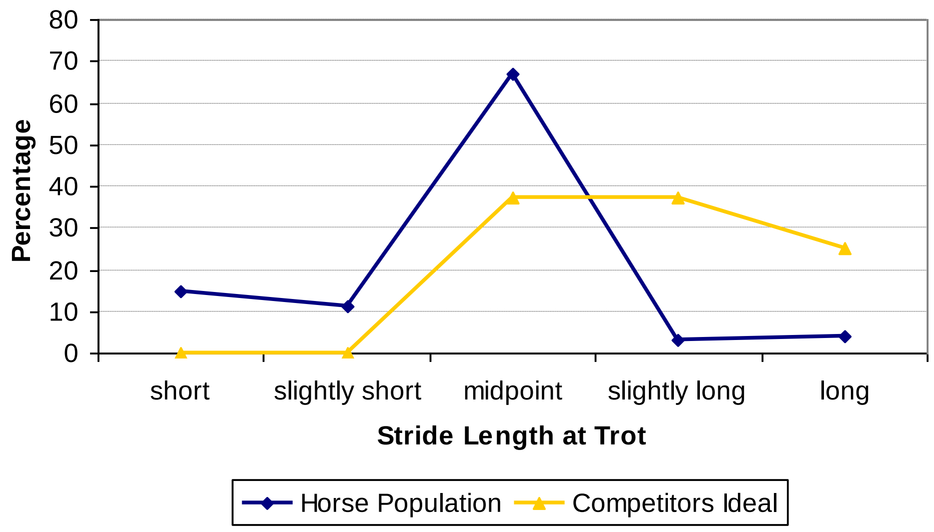


Figure 86: Comparison of Stride Length at Trot in the Study Population with Competitors Opinions on Ideal

Impulsion in trot was favoured on the powerful side by the majority of competitors, with only a small percentage favouring average impulsion. None of the competitors favoured slightly weak to weak impulsion. The majority of horses in the study population had average impulsion at trot and a minority had slightly weak to weak impulsion. Only a small percentage displayed slightly powerful to powerful impulsion. Ultimately the pattern of what is required and what was observed, were very different (Figure 87).

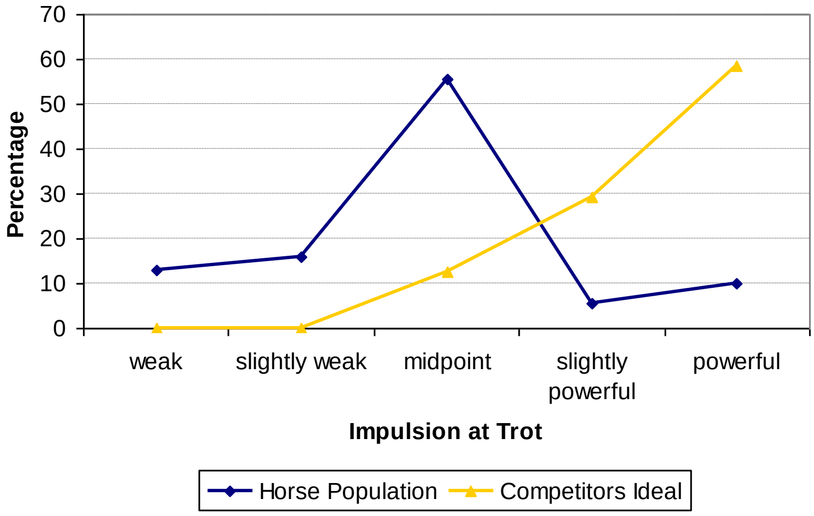


Figure 87: Comparison of Impulsion at Trot in the Study Population with Competitors Opinions on Ideal

All of the competitors favoured no deviation at the trot with the majority of horses observed to fall into this category. A slightly higher percentage of horses were observed to slightly dish or dish than slightly plait or plait (Figure 88).

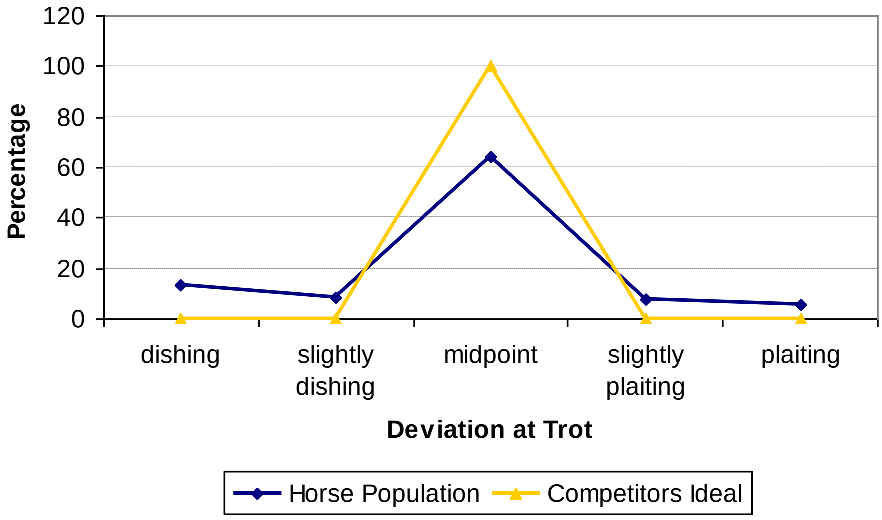


Figure 88: Comparison of Impulsion at Trot in the Study Population with Competitors Opinions on Ideal

Chapter Five

Discussion

Chapter 5: Discussion

5.1 Evaluation of Future Event Horse League Data

5.1.1 Comparison of Judges Scores

The aim of any performance based selection is to improve and monitor the quality of the animals produced. This is only possible if the assessment of animals is consistent. In order to make genetic progress, assessment has to be accurate. To validate the accuracy of assessments in this study, Intraclass Correlation Coefficients were used to determine consistency. This is necessary due to the difference in use of the range of scores by judges in any traditional judging system. It would be of no value to assess whether judges agreed on an absolute value for the same animal, instead it was assessed whether the judges awarded their high, low and average scores to the same animals within their own scoring ranges. Results showed a fair to almost perfect agreement. Only one pairing of judges was observed with an ICC value not significantly different from zero, indicating a lack of agreement between these judges. All other ICC values ranged from 0.370, which indicates fair agreement to 0.952, which indicates almost perfect agreement. Additionally it has to be stated that only two judge pairings resulted in fair agreement, all remaining ICC values indicated moderate to perfect agreement. These are encouraging findings, considering that Magnussen (1985) in an introductory study found large discrepancies between judges in judging conformation subjectively, due to these results the study concluded that subjective judging showed great errors and was not suitable to be used in further analysis. Preisinger (1991) observed similar trends in a study sample of Trakehner horses, where judges were measured on their accuracy by the mean values and some judges were off by more than half a point on a ten point scale and only 50 – 60% of the full range of the scale were used. However, these studies are somewhat difficult to compare due to the method of determining the agreement between judges.

Relatively few studies in horses have used ICC and yielded discouraging results. In a study using Irish Draught horses traditional and linear scoring was carried out and the highest ICC value achieved was 0.234 for the traditional scoring method and 0.320 for the linear approach, neither ICC value indicate satisfactory agreement. As neither method indicated satisfactory results it may just be due to the judges and their training. Direct comparison with the present study cannot be made as absolute agreement was tested in the Irish Draught horse study (Breen, 2009). However, a study in Dutch dairy herds yielded comparable results where claw trimmers observed lesions in cattle and ICC values ranges from 0.4 to 0.9. To improve inter-observer repeatability the study by Holzhauer et al., (2006) recommended practical claw-trimming sessions prior to assessment, replacing verbal or written briefing (Holzhauer et al., 2006). Practical briefing sessions may also be of value in horse related studies when selection for specific traits is of importance.

5.1.2 Comparison of First Qualifier Scores and Last Qualifier Scores

To assess the effectiveness of the FEHL in selecting event horses for elite level, horses' scores were compared between the first qualifier and the last qualifier that the horse attended. In three of the four phases suitability and potential for advanced competition is assessed, which should not change with a progression in training. Results of this study show that there was no significant difference between scores achieved for any of the three suitability and potential phases. There was no significant difference in scores achieved in the earliest competition attended to the last competition attended in the suitability and potential of Ridden Display, Conformation and Movement and Jumping. This is an encouraging result as judges even at different times of the stage of training of the horse still scored horses similarly to the start of the season, which indicates that judges follow the briefed guidelines closely and assess talent accurately. However, there were significant differences observed in the Ridden Display Scores, with horses scoring higher in the last qualifier attended compared to the first qualifier. This was to be expected, due to the same test being ridden throughout the duration of the league, horses and riders should become more accurate with the execution of the test due to the progression in the horses training. Both of these effects have been documented in earlier studies. Kearsley et al., (2008) found an improvement of dressage scores throughout the progression of event horses into higher levels of eventing. Another study in dressage horses observed that horses progressing in their dressage training are able to perform more direct transitions and take fewer steps to achieve these (Tans et al., 2009). This outcome validates to a certain extent the scoring of the dressage judges. If no improvement was observed within a season the judicators might have to be questioned on their methods. Equally the judges scoring Suitability and Potential reaching the same conclusion at different times of the season indicates a consistency between them in assessing the potential of these young horses.

5.1.3 Effect of Age, Gender and Year on Average Scores in all Phases

5.1.3.1 Effect of Age on Phase Scores

Average scores in this study were significantly affected by age. In each phase 4 year old horses scored on average lower than 5 year old horses. The largest difference in scores was in the Ridden Display phase, where 4 year old horses scored almost 5 points less on average compared to 5 year old horses. One explanation especially for the ridden display phase and suitability of jumping phase could be that as horses progress in their training they are more familiar with the environment and their training is more advanced as 5 year olds. Studies have shown that as horses get more experience they improve their scoring (Wikström et al., 2005, Kearsley et al., 2008). In contrast to this, studies have shown higher scoring in younger mares at performance testing in Dutch Warmblood horses (Huizinga et al., 1990), and a higher scoring of 5 year old horses at pre-novice events compared to older horses (Whitaker et al., 2007). A reason for this could be that older mares presented at performance testing may have been in foal prior to performance testing and not in training, similar to older horses presented at pre-novice events that may have never progressed even as young horses therefore staying at pre-novice level instead of upgrading. However, the conformation phase should change to a lesser degree as conformation judging should be based on the skeletal makeup rather than muscling of the horse. The immaturity of some horses at 4 years of age may offer an explanation, as particularly large horses are considered to have longer maturation times. Beeman (1973) recognised this in a study on defects in conformation and stated that the dynamics of equine locomotion depend on development, nutrition, physical fitness, health, training and conformation. Furthermore, all of these can be altered to some degree, except for conformation. As most conformation traits cannot be altered it is therefore surprising that conformation scores are lower in 4 year old horses, indicating that other variables such as inexperience of the horse may have affected the trot-up such that scores could not be awarded by the judges, or failure of the judges to see the potential in a less experienced, less developed animal.

5.1.3.2 Effect of Gender on Phase Scores

There were significant effects of gender on the Suitability and Potential of the Ridden Display and the Suitability and Potential of Conformation ($p < 0.05$). Mares achieved lower average score than geldings. This may indicate a lower potential of the mares for dressage and less suitable conformation and movement for elite level of competition. Additionally, oestrus behaviour may influence mare performance (McCue, 2003). In a study on the relationship between conformation, performance and health in 4 year old Swedish Warmblood Riding Horses, similar trends were observed. Male horses, 9 stallions and 103 geldings, achieved significantly higher scores for canter, type and conformation (Holmström and Philipsson, 1993). Holmström et al., (1990), in a study on variation of conformation, found significant differences in conformation in mares. These included a smaller height at the withers, longer body length, shorter limbs, narrower front cannon bones and metacarpal bones, smaller hock joint angles and larger hind fetlock angles. These traits are all deemed unfavourable for performance and this may be a reason why mares scored lower in the present study. However, a study (Whitaker et al., 2007) in event horses at pre-novice events reported only a very small difference between mares and geldings. The final penalty score showed a difference of 0.8 between genders and was not significantly different. No significant differences were found between mares and geldings in the Ridden Display and Jumping Phase in the present study. An explanation for this may be that judges for these two phases are a little further away from the animals and may not necessary be able to tell the difference in gender. Additionally, the score sheets for these phases have a lot more scores to award which puts the focus on the scoring requirements, in the other two phases fewer scores are awarded in a longer timeframe. This long timeframe allows the judges to look in more detail at horses and may introduce a certain bias towards mares.

5.1.3.3 Effect of Year on Phase Scores

In order to observe trends in conformation, movement and training developing it is necessary to monitor a population of performance horses at a young age over given time periods. This enables studbooks to identify strengths and weaknesses early and deal with them appropriately, which in turn may shorten the generation interval in order to stay competitive in the market for which they aim to produce.

The effect of years on the average scores attained by horses in the Ridden Display phase were similar for the first four years, with the exception that 2006 and 2007 results were marginally higher than 2005. In 2008 horses scored significantly lower in this phase compared with all prior years examined. This is a concerning result and it may indicate a lack of training and development of the horses in more recent years. In 2009 results were similar to the first two years examined, indicating a positive response of trainers and riders to the lower scores achieved in 2008.

Suitability and Potential of the Ridden Display was similar in 2006, 2008 and 2009. In 2007 horses were judged to be more suitable in this phase compared to other years. This phase is judged according to the suitability of paces or movement under saddle and the model or type required for 4 star competitions. This indicates that horses in 2007 were more suitable for requirements at 4 star levels.

In the suitability and potential of conformation phase some concerning trends were observed. Average scores in 2004, 2007 and 2009 were not significantly different, 2005 and 2006 had significantly higher average values and therefore conformation and movement were better in horses in those years. However the biggest difference was observed in 2008, where significantly lower average scores were observed in horses compared to other years. From the level of scores observed in 2005 and 2006 average scores have been falling in 2007 and 2008, indicating less suitable conformation and movement for the sport as assessed by experienced judges. The nature of subjective scoring makes it hard to identify which conformation traits the animals in the 2008 population were lacking, however it clearly shows a trend toward lower scores. Another reason for the lower scores may have been that judges scored horses harder, although this seems very unlikely as judges change at every qualifying venue and from year to year. Conformation scores for horses were up again in 2009; this may suggest that the lower conformation scores of the horses in 2008 could have been an exception and may indicate that conformation in these hoses was not up to standard of previous years. A previous study evaluating performance and orthopaedic status in Standardbred trotters looked at year effect on the variables but found no significant differences (Thafvelin and Magnusson, 1985). In contrast to this a German study in Mecklenburger Warmblood horses showed a significant increase in subjectively scored conformation traits and total breeding values, showing significant genetic improvement over a period of 12 years (Dietl et al., 2004). Genetic progress in selection for a specific purpose, according to the changes in breeding objectives was carried out in French Sport horses.

An improvement in the selection was observed continuously in all newly defined breeding objectives jumping, dressage and eventing since 1985, proving that breeding objectives for more than one discipline can be effective as all disciplines made genetic progress (Dubois and Ricard, 2007).

Similar trends as in the conformation phase were observed in the suitability and potential of jumping, where scores were up and down for the first 4 years examined and then fell significantly in 2008 below all other average values observed in previous years. Scores were back up in 2009 to comparable levels in the years 2004 to 2007. The low scores in 2008 could be attributed to similar reasons ascribed for the decrease in conformation scores with a decrease in the quality of animal presented. However, it may also be due to training and preparation of the horses. Along with the abolition of the roads and tracks phase, dressage has gained more importance overall and we may observe the effects of this as training of horses may concentrate more on dressage and substantially less time may be spent jumping obstacles and at speed. This training may have somewhat affected the performance in the jumping phase and horses may not be as well prepared for this phase.

5.1.3.4 Effect of Breed on Phase Scores

In recent years the popularity of foreign bred sires for breeding purposes has increased in Ireland, probably in an attempt to improve performance of the Irish horse in showjumping. To estimate the impact of the foreign sire influence on the eventing potential of young event horses in Ireland, breed effect was analysed in relation to phase scores achieved. A trend towards an increase in the proportion of horses with foreign breeding were seen from 2006 and 2007 compared with 2008 and 2009, however this increase (10%) was not statistically significant.

Average scores of suitability and potential of ridden display, where the movement and type under saddle was evaluated, showed significantly higher results in foreign bred horses compared with Irish bred horses. In all other phases no significant differences were found. This may be a reflection of an early onset of maturity or a difference in temperament (Lloyd et al., 2008).

Since the abolition of the long format of eventing and the introduction of the more technically demanding courses the question arises whether the thoroughbred horse is still as suitable for the sport of eventing. There was no significant difference in performance in Ridden Display scores and Suitability and Potential of Conformation between Foreign bred, Irish bred and thoroughbred horses. However, in the Suitability and Potential of the Ridden Display similar results were observed between Irish bred and Thoroughbred horses, with Foreign bred horses scoring higher.

The most surprising finding was that thoroughbred horses scored significantly lower in Suitability and Potential of Jumping, compared to Foreign and Irish bred horses. A possible explanation is offered in the result of a study on early training of jumping in horses (Santamaría et al., 2006). Horses were assessed at 6 months of age, as 4 years of age at a selection event, and as 5 year olds at a puissance competition. One group of horses received early training while the other did not. Horses which received training displayed better front leg technique than horses not trained, at age 4. However, at age 5 these differences were not significant. In the present study similar events may have taken place. In Ireland young non-thoroughbred horses tend to be loose jumped more frequently than thoroughbred horses in their early careers, largely due to 3-year-old loose jumping competitions included in the programme of showjumping venues around Ireland. This may have resulted in these animals scoring higher in the Suitability and Potential of Jumping phase.

5.1.4 Correlation of Scores between different Phases

The existence of correlations between scores in all phases was determined to investigate whether scoring in one particular phase may indicate performance in another. Results were rather limiting in that modest correlations were obtained in the correlation between the suitability and potential of conformation with suitability and potential of the ridden display ($r = 0.535$). However, this was expected as in both of these phases gaits were assessed, accounting for half of the scores analysed. The lowest correlations found were between the ridden test and suitability and potential of jumping and the ridden test and suitability and potential of that ridden test. Although these correlations were very low, the relationship was significantly different from zero. Correlation coefficients indicating modest relationships were found between suitability and potential of the ridden test, conformation and jumping. Three of the four phases analysed should indicate the potential of the horse as a future event horse and therefore these phases should show some correlation, although judging briefs are different for all these parts (Future Event Horse League, 2009). In the Hannovarian Warmblood horses, conformation traits and jumping are negatively correlated, with correlation values as low as -0.31, and conformation traits with dressage strongly positively correlated, with correlation coefficients up to 0.59 (Christmann, 2007). Correlation values from von Lengerken and Schwark (2002) and Christmann (2007) are comparable with values found in the present study. Ridden test scores and suitability of conformation scores failed to show a significant correlation. This was not surprising as the execution of a ridden test at this level should pose no difficulties to a horse with less than optimal conformation as only basic training principles need to be displayed.

5.1.5 Comparison of Traditional Scores and Conformation Score Sheets

For comparison of the more descriptive conformation sheet, correlation with all four phases was carried out. Similar to the traditional conformation scores, the new conformation score sheet results failed to show a significant relationship to the Ridden Display scores. All other phases showed a significant positive relationship ($p \leq 0.001$) ranging from 0.246 to 0.473. These results compare well with traditional methods as it resulted in similar correlation coefficients and the bigger range of traits scored in a shorter timeframe. Von Lengerken and Schwark (2002) found slightly higher correlation values between conformation traits and dressage ability at mare performance testing with ranges from 0.46 to 0.54. In the present study the correlation coefficient between suitability and potential of ridden display was 0.386 and 0.246 with jumping potential. In comparison Von Lengerken and Schwark (2002) showed negative correlation values between conformation and jumping potential. The highest correlation coefficient was found when comparing conformation scored by FEHL judges traditional conformation assessment and the authors use of the more descriptive conformation score sheet. This is encouraging and indicates that a more descriptive conformation evaluation approach achieves similar results and can be carried out in the same timeframe.

5.2 Interview Questionnaire Results

According to Koenen et al. (2004) breeding objectives of warmblood sport horse studbooks are sometimes very loosely worded and although they may specify their goal to breed a performance horse that can compete in show jumping, dressage and eventing, they fail to accurately describe traits necessary to succeed or even breeding strategies to produce the desirable traits. In order to provide breeders and producers of event horses with guidelines for desirable conformation and movement traits, interviews with elite event riders were carried out.

Questions early in the interview related to selection preferences. Over half of the competitors responded that temperament was the most important of the selection criteria offered, just under a quarter answered that price was the most important and only the third most selected answer was conformation. This is an interesting finding considering the huge demands eventing places on the skeletal system (Dyson, 2000). Interestingly in the analysis of breeding objectives for warmblood horses by Koenen et al. (2004), it was found that 11 of the 19 breeding organisations included temperament as a trait for their breeding objectives. However, of the 11 that stated eventing as one of their objectives only 6 stated behaviour to be of importance. Temperament is recognised by many studbooks as an important trait and is therefore included mainly in performance testing (Bruns et al., 1978, Huizinga et al., 1990, Wallin et al., 2003, Viklund et al., 2005, Albertsdóttir et al., 2007, Olsson et al., 2008).

Performance tests in young horses are routinely assessed on 4 year old horses in a number of studbooks. It is therefore no surprise that the most common age profile bought by elite competitors were 4 year old horses, this age group was preferred by almost a third. Second most frequently purchased age group were 3 year old horses. An explanation could be that at this age horses development is at a stage where training can begin and potential can be assessed under a rider.

In light of the new short eventing format it was interesting to find out what breed of horses are preferential in the sport. Traditionally, in the long format, a predominance of thoroughbred blood was necessary to excel in order to cope with the speed and stamina required for the steeplechase, roads and tracks and cross country in the same day. Pure Warmblood horses were struggling to achieve the speeds required at elite level and when working at such high speed continuously were more prone to injury according to Dyson (2000). Bokor et al. (2007) agrees with this statement but predicted that with the introduction of the new rules by the Federation Equestre Internationale that with a shortening of the cross country distances the importance of thoroughbred blood would decrease over time. This study found the contrary to be true, over half of the riders interviewed stated that the most suitable breed for eventing today is a traditional Irish

Sport Horse crossed with thoroughbred and the second most preferred option was pure thoroughbred and the next most selected option was Irish Sport Horse, which is the traditional cross of Irish Draught with thoroughbred. This could be due to riders being used to a certain type of horse and an unwillingness to move on to horses that have yet not proven themselves in the sport. However, it clearly demonstrates that there is still a market for the traditional Irish horse.

To get some idea of where elite riders source their horses, the question was asked where they usually buy their horses and the majority bought from private vendors. Furthermore, the question was asked how much money they would consider spending on a three year old horse and a third would spend up to €10,000, a quarter of competitors would spend up to €5,000 and a slightly lower proportion would spend up to €15,000.

5.3 Evaluation of Descriptive Conformation Traits and Opinions in Relation to Conformation Traits

5.3.1 Traditionally Scored Descriptive Traits

Each individual trait was scored on a ten point scale and the distribution of results on the scale used for each trait was in a fair region. Mean values of the traits ranged from 6.20 to 6.90, which is in line with what previous studies reported for subjectively scored traits on a scale form 1 to 10 in a variety of horse breeds (Schwark et al., 1988, Huizinga et al., 1991b, Gerber Olsson et al., 2000, Dietl et al., 2004, Love et al., 2006, Stock and Distl, 2006). The largest proportion of the population of horses fell within the fair region in all ten traits, ranging from 54.7% of horses scoring fair marks for feet, up to 80.8% of horses scoring fair marks for structure. The remainder of scores aside from the main percentage is less on the poor side, which means good scores were awarded more frequently than poor scores. A possible explanation for good scores being more frequently awarded than poor scores may be because the competition demands a lot from young horses in order to identify future event horses. In order to cope with these high demands only horses deemed suitable and trained to a certain degree are brought forward acting almost as a pre-selection. In the hoof conformation trait, the distribution shifted to the upper bound of the scale with the majority of horses scoring well for feet traits. This is encouraging and may indicate better than average hoof conformation of this population of horses. Interview results outlined bad foot conformation was considered to be of great hindrance to the sport (see section 4.4.1), therefore findings of good foot conformation in this population is of benefit for the purpose of eventing. Additionally, the literature describes foot conformation of utmost importance for effective shock absorption and poor conformation is indicated to distribute pressure unevenly resulting in lameness, true to the common statement “no foot, no horse” (Adams, 1987, Anon, 1999, Back, 2001b).

5.3.2 New Conformation Scores in Relation to Competitor Opinions

The highest proportion of the population for all traits, apart from loin muscling, was found at the midpoint between biological extremes. For this reason only percentages of the population on either side of the midpoint of scale are discussed in relation to the competitors’ ideal conformation.

The head neck connection is preferred at the midpoint by half of competitors and another large proportion preferred a slightly light or light head connection. Horses in the population studied conform well to this ideal as a larger proportion tend toward the light side compared to the heavy side. This conformation was found to be more prevalent in elite dressage and show jumping horses by Holmström (2001) compared to ordinary riding horses, strengthening the argument for a lighter head neck connection.

Neck body connection is preferred slightly narrow or higher set by just under half of the elite riders. Additionally 20% preferred it narrow. However, opinions of the remainder of elite riders were spread out equally over the other three categories indicating that there is no clear consensus on what is the ideal. Conformation of the head and neck connection of the sample population was spread equally on both sides of the scale. The ideal would be to see more horses on the lighter side to meet the competitors preferences. Very few studies were found in relation to neck body connection, although the Dutch Warmblood Studbook KWPN (KWPN, 2009) describes a more horizontal set neck (lower set) of advantage to jumping horses in order to achieve enough collection for take-off and a more vertically set neck for dressage horses to achieve self carriage and uphill movement. Taking that into consideration, the midpoint may be the most appropriate, which disagrees with the opinions of competitors.

In regard to the length of neck, competitors opinions are more in agreement as 75% prefer the midpoint, in other words a medium length neck. A smaller percentage favoured a slightly longer neck. In the population of horses almost 20% were described as having short necks and almost none were on the longer side of the midpoint. Trends therefore indicate that a shorter neck is more prominent in Irish bred horses than longer necks. The disadvantage of a short neck is less flexibility in the neck and a short choppy stride (Oliver and Langrish, 1991, Loving and Langrish, 1997, Anon, 1999), however long necks are associated with laryngeal paralysis and front fetlock effusion (Anderson et al., 2004). The strong Irish Draught influence in Irish Sport horse breeding may cause short necks to be more prevalent in this population.

A slight topline is seen as ideal neck muscling in event horses. However the population of horses in this study showed a prevalence of slightly poor to poor muscling. It could be suggested that horses in the study sample are still immature at 4 and 5 year of age and therefore training intensity is low and more focused on skill acquisition rather than fitness and muscle build up is consequently lacking.

Average height withers, in between high and flat wither conformation, are preferred or slightly high conformation. The literature supports this view, as medium to high withers are associated with long sloping shoulders, making them ideal for a full range of movement and maximal engagement of the back over obstacles (Oliver and Langrish, 1991, Holmström and Philipsson, 1993, Loving and Langrish, 1997, Anon, 1999).

Sloping shoulders are clearly preferred and none of the competitors indicated straight shoulders to be of advantage to event horses. This agrees with studies in performance horses where longer more sloping shoulders were more prevalent in more successful animals (Thafvelin and Magnusson, 1985, Holmström et al., 1990). Additional studies clearly showed that long sloping shoulders were associated with longer stride length, improved orthopaedic status and a reduced risk of lameness (Beeman, 1973, Holmström and Philipsson, 1993, Ross, 2003a). It is for these reasons that it is worrying to observe an almost equal proportion of horses with straight or slightly straight shoulders as horses with slightly sloping or sloping shoulders in this population. This is a cause of concern as athletic potential may be limited due to a higher risk of lameness in horses with straight shoulder conformation (Magnusson and Thafvelin, 1985, Holmström and Philipsson, 1993, Anderson et al., 2004). One reason for this result may be linked to the handlers presenting their horses in a way to make the shoulder appear straighter; however most of the competitors at the FEHL are experienced horsemen that have sufficient knowledge of presenting a horse in hand.

Knee conformation was only assessed in a lateral view and more horses were back-at-the-knee (18.5%) than over-at-the-knee (10.1%). Competitors clearly indicated a preference to the midpoint and a smaller proportion to slightly forward or over-at-the-knee conformation. Almost a fifth of all horses were back-at-the knee to some degree in this population of event horses. A study in thoroughbred yearlings found a prevalence of 6.6% of back-at-knee conformation and found it negatively correlated with racing performance (Love et al., 2006). In Norwegian cold-blooded trotters prevalence of back at the knee is very high with an incidence of 36.8% (Dolvik and Klemetsdal, 1999) and it was found a very common conformational fault in Standardbred pacers (Ross, 2003a). Beeman (1973), Adams (1987), Dyson (2000) and Bathe (2003) agree that this conformational fault is one of the most serious conformational fault in the limb that causes a string of problems and will not stand the test of time. Again a strong influence of the Irish Draught horse may contribute to this fault in the Irish horse, due to its higher prevalence in draught breeds (Breen, 2009).

Pastern length was preferred at medium length or slightly short. The population of horses conformed to this ideal with a fractionally higher percentage of horses with weak or longer pasterns. Overall conformation of the pastern was over 80% at an ideal medium. This is a positive finding considering the high thoroughbred influence in Irish horses, as Marks (2000) reported higher incidence of long sloping pasterns in thoroughbred horses that are a common cause for breakdown.

Cannon bone substance was relatively inconclusive to determine an ideal, just over a third of elite riders preferred medium strength bone and about 45% preferred stronger bone and some (16.7%) answered slightly light boned conformation to be ideal, indicating no clear preference in this trait. None of the competitors felt light bone conformation to be suitable for an event horse. Yet 29% of horses in the sample population that were scored were lacking in bone substance. Magnussen and Thafvelin (1985) found more splints and synovial distension in the fetlock with larger cannon bone circumference in Standardbred trotters, as harness racing puts similar severe stresses on horses legs this is interesting, as elite riders expressed a preference to the stronger bone conformation. As with pastern length it may be that the strong thoroughbred blood influence in the population study may produce horses with less cannon bone substance.

The gaskin and quarters of an event horse should be strong according to competitors. Any weakness in this area is undesirable. In gaskin conformation some horses were slightly weak (14.4%), but this may again be attributed to immaturity and a lack of fitness training. Muscularity of the quarters had equal proportions on either side of the midpoint (12.7% strong vs. 13.5% poor). Poor muscling in both the gaskin and quarters may correct with maturity and fitness of the animal. Due to the age of the sample population this trait may further develop.

Conformation of the hock should be at the midpoint between sickle and straight hocks, or slightly sickle according to the elite riders. In the population sample sickle hocks are very widespread with over 30% being sickle hocked to some degree. The literature agrees with riders that a sickle hock or an excessively straight hock are of disadvantage to performance in horses (Beeman, 1973, Magnusson and Thafvelin, 1985, Adams, 1987, Anon, 1999, Ross, 2003a). Diseases of the hock such as curbs are common in sickle hocks and are related to a decreased orthopaedic status, represented in some form of lameness. Holmström et al. (1990) reported in order for horses to excel to elite level this trait needs to be absent.

Medium width feet are desirable, with a medium heel height or slightly high to high according to competitors. Low heels were not indicated to be desirable by any of the competitors. A small percentage of horses in the selected population had wide feet (12.6%) and the incidences of narrow feet (3.6%) were very low. The percentage of horses with low heels (18.6%) were a lot higher than those with higher heels (6.2%). Usually horses with flat or wide feet also have low heels and the negative effects of this are discussed in section 4.4.1. This particular abnormality is more common in lighter bred horses according to previous studies (Adams, 1987, Anon, 1999), which explains the increased occurrence in this particular population of horses. The majority of horses in the study were crossbred with thoroughbred to some extend.

Half of the competitors interviewed were of the opinion that medium length back was the conformation ideal for event horses. The rest preferred slightly short or even short backs. Magnussen and Thafvelin (1985) support the latter contention with fewer back pain problems in Standardbred trotters with short backs compared to horses with long backs. In the study sample of horses, almost a quarter of horses (26.8%) fell into either a slightly long or even long length of back category. This trend is a cause for concern and should be monitored closely as long backs are generally weaker backs unless coupled with a strong loin region. Further discussion on this trait is in section 4.4.1. A strong loin area was identified as ideal conformation for event horses in the opinion of the elite riders. The results of the conformation analysis of the sample population identified a weak or slightly weak loin area in the majority of horses (54.8%). This trend must be monitored as backs with weak loin areas are usually coupled with a longer back and this will only increase negative effects of long back conformation even further. An explanation for some horses with weak loin areas may be that with maturity and increasing fitness this area may strengthen. Although not quantified, a lot of horses in the study population were "croup high", the croup appears higher than the withers in a lateral view, in relation to wither height, which may give the loin area an even weaker appearance.

A sloping or slightly sloping shape of croup was preferred over a flat croup by half of all elite riders taking part in the study. Population findings correspond with a trend more towards the sloping shape of croup and only a very small percentage of horses presented with flat croups (5.6%). In contrast, previous studies favour flat croup conformation over steep croups with the reasoning of a more ground covering stride (Anon, 1999, Ross, 2003a). Additionally a study by Holmström (2001) established flatter croup inclination in groups of elite performance horses in dressage and showjumping. It is however unclear how meaningful these findings are in relation to the present study, as every study used different reference points to determine croup conformation.

Shape or structure of conformation as a whole was assessed and almost half of competitors favour a square or slightly square shape, almost a third preferred a medium frame and a smaller percentage stated a more rectangular shape advantageous. Shorter body forms are associated with a strong, durable structure, which supports the competitors' views (Druml et al., 2007). Additionally Mueller and Schwark (1979) found horses competing in showjumping, dressage and three-day eventing were squarer in structure. However, more recent studies do not agree that shorter body forms are more suitable for performance and a trend to a more rectangular horse is being followed by several studbooks (Holmström et al., 1990, Weller et al., 2006a, Christmann, 2007, KWPN, 2009). The present study found similar trends, as more than a third of horses (34.9%) exhibited rectangular or slightly rectangular shapes, indicating a longer body form This is moving away from what elite riders consider ideal and follows more recent trends in breeding, which have not been proven to be favourable for eventing. Maybe the recent introduction of some "continental" warmblood sires into breeding could have brought about a change in the shape of the Irish horse. Additionally this may be the cause of the high prevalence of long backs that was observed in the study population.

Stride length at the walk should be long and not deviate ideally, according to the elite riders. This corresponds to findings in the sample population where a trend towards a slightly long or long stride length in the walk can be observed in almost a third of horses (32.3%). Only about 10 % of horses toe in the walk and a slightly higher percentage of just over 20% toe out. This is in line with findings in studies that report the prevalence of toe out conformation to be so common as to interpret it as normal conformation (Thafvelin and Magnusson, 1985, Love et al., 2006). However in severe cases this abnormality can cause interference with the opposite leg, which at the speed of the cross country phase may have serious implications.

In the trot 75% of competitors favour average stride length or slightly long stride length the most, with a powerful or slightly powerful impulsion and no deviation. A quarter of horses presented with stride length on the short side of medium length and more on the weak side of impulsion. Additionally dishing is slightly more prevalent than plaiting (21.9% vs. 13.5%). Barrey (2001) describes the qualities of a good trot as a slow stride frequency with a long swing phase and maximal propulsion, this is essentially powerful impulsion, this agrees with the ideal set out by competitors. In contrast, the horses observed showed a weakness of impulsion, which may be due to training in hand. Bad training or no training in hand can affect impulsion or even hinder it in a young horse as the handler can affect the horse's balance through interference with the bit. Only a small effect should be seen on the results and with 28.8% of horses lacking in impulsion, it is more likely that the trot is just not of good enough quality. Results from the interviews on canter variables, such as stride length and impulsion, were very similar to trot results.

5.4 Open Answer Questions

5.4.1 Abnormalities in Conformation with a Negative Influence on Eventing

Some open answer questions were asked, to give riders a chance to express anything important in relation to selection that may not have been expressed in the set answers given previously. Competitors were asked what type of abnormality in conformation they consider a hindrance in the sport of eventing. The most common answer was related to conformation of the feet, over half of the competitors considered flat or bad feet to be a particular problem. Studies have shown that flat feet are prone to bruising and considering event horses jump onto varying terrain during the cross-country phase flat feet are not suitable (Adams, 1987, Anon, 1999).

Bad pastern conformation was considered a problem by just over 40% of competitors. In particular long and sloping pasterns or short and upright pastern conformation were considered to be a hindrance to the sport. This agrees with Bathe (2003), who believe that long sloping pasterns are a hindrance in eventing. Due to the large selection of horses with some degree of thoroughbred breeding for eventing, long sloping pasterns may be more commonly observed than in other populations as documented by several studies on thoroughbred horses (Marks, 2000, Anderson et al., 2004). Both studies linked them to an increased risk of breakdown in thoroughbred horses.

Slightly over a third of competitors considered general bad leg conformation, such as crooked legs most likely referring to bench-kneed, knock-kneed or bow-legged conformation, and bad knee conformation as viewed laterally especially back-at-the-knee and tied in knee conformation as a hindrance in the sport. This is not surprising as several authors observed faulty limb conformation, such as the ones listed by the competitors, have negative effects on performance, as horses are more likely to suffer lameness, chip fractures, splints and ligament injuries due to the uneven loading of the distal limb (Beeman, 1973, Magnusson and Thafvelin, 1985, Adams, 1987, Dyson, 2000, Bathe, 2003, Ross, 2003a, Anderson et al., 2004, Weller et al., 2006b). Therefore it unlikely for horses with these abnormalities to last in top level eventing.

Interestingly, of all the abnormalities in conformation listed to be undesirable for the sport 7 out of 11 were leg abnormalities. This demonstrates how important leg conformation is for the sport of eventing and therefore particular care should be taken to select for ideal leg conformation. This importance is highlighted further in an analysis of injuries in event horses, limbs are the most commonly injured anatomical region in eventing accounting for 86% of all injuries experienced in event horses (Singer et al., 2008).

Apart from leg abnormalities a relatively high proportion (25%) of competitors considered abnormal back conformation as a hindrance. In particular it is worth mentioning that long backs are considered very unsuitable. Previous studies have identified long back conformation as faulty due to increased muscular and ligament strain and some difficulties with collection (Jeffcott, 1999, Anon, 1999). However, Jeffcott (1999) described long back conformation to be of advantage for sports such as dressage as long backs are more supple. From this analysis it is clear that it is not considered a desirable trait for eventing. It would most certainly contribute in an increase of breakdown of horses in the sport and longevity is vital to an event horse in order to reach the highest level competition.

5.4.2 Personal Criteria for Selection

When buying a horse for any specific purpose it often comes down to personal preference. Some riders prefer a slighter build of horse, some prefer bigger framed horses, some prefer extravagant movement and others would choose differently again. In light of personal preference the last question was “When buying an event horse. What are your criteria for selection?" A variety of answers waere expected, however almost 90% of riders agreed that the attitude or temperament of the horse is their criteria for selection. In the previous question where competitors got to rate selection criteria temperament was selected as the most important. Behaviour therefore must play a very important part in eventing performance that cannot be easily evaluated. Riders specified further that horses they selected in the past had a ‘look at me factor’ about their attitude and behaviour. The belief that temperament or attitude may influence performance is supported by Visser et al., (2003),which proved that it is possible to predict a substantial part of jumping performance by personality traits assessed earlier in life. The tests to assess personality in horses in this study included novel-object test, handling test, avoidance-learning test and a reward-learning test. Horses in the study by Visser et al., (2003) were subjected to the personality test earlier in life and as three year olds they were backed and trained under similar circumstances and presented with a novel jumping course, 63% of variances in the show-jumping performance were able to be linked to variables of the personality test. This strongly supports the competitors belief that temperament is the most important performance variable to consider when selecting a future three-day event horse.

Chapter Six

Conclusions and Recommendations

Chapter 6: Conclusions and Recommendations

- Average Suitability and Potential Scores of horses remained consistent from the first to last qualifier attended. Ridden Display Scores improved, indicating that with training and education horses produce better performances in this phase.
- ICC values demonstrate good agreement amongst FEHL judges on the quality of horses. FEHL therefore may be an underutilised resource with potential use to the horse industry. Average scores of horses could be utilised to compile data on event horses for the future. All areas of judging in horses including FEHL could benefit from practical briefing session to increase scoring accuracy between judges further.
- 5-year-old horses generally score higher than 4-year-old horses in all phases showing that experience and training play a big role in performance results in young event horses.
- Mares scored on average significantly poorer in Suitability and Potential of Conformation and Suitability and Potential of the Ridden Display. This may highlight the need to have adjusted guidelines for mares to eliminate potential bias towards mares.
- The year 2008 yielded the lowest Suitability and Potential Scores for Conformation and Jumping from 2004 - 2009. This highlights the need to monitor the conformation decline and potential knock-on effects of such. Equally the jumping performance loss is of concern, supporting recent worries that with the introduction of the short format, that the emphasis placed on training for the cross-country phase has been neglected. The lack of training and the introduction of more technical courses may contribute to the steep increase of serious falls at the cross country phase.
- Temperament is one of the most important selection criteria for event horses among elite riders, highlighting a potential need to include this as a selection criterion in the future.
- The Irish Sport Horse crossed with thoroughbred is still considered to be the most suitable breed for eventing among elite riders. Highlighting that although there was a major change in the sport the requirements on breeding have not changed.

- The evaluation of conformation in this study highlighted a relatively high prevalence of some unfavourable conformation traits for eventing such as: straight shoulders, back-at-the-knee conformation, sickle hock conformation, long back conformation, weak loin area, rectangular structure and lack of impulsion in the trot. Monitoring these unfavourable traits will be imperative going forward in order to keep producing top quality animals for the sport and reduce their prevalence in the population. Introduction of sires and broodmares from other studbooks with breeding aims to breed rectangular structures may not be of advantage considering short frames and backs are desired in the sport of eventing.
- Based on the interview results with competitors, it is apparent that selection criteria for event horses should be distinct from those used in the selection of showjumping horses

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Appendices

Appendices

Appendix 1 Interview Questionnaire

University *of* Limerick

<u>"Selection Criteria for Three Day Event Horses in Ireland"</u>

Background information:

1. Gender:

Male □ Female □

2. Age group:

< 20 □ 21-30 □ 31-40 □ 41-50 □ 51-60 □ 60 + □

3. Eventing experience:

Compete/d at ***/**** level □
Trained horses at ***/**** level □
Trained riders at ***/**** level □
Other □
*Please specify*____

4. Selection criteria:
Rate these criteria in order of importance when selecting a horse specialised for the sport of eventing. (1 – most important and 5 being the least)

Price
Temperament
Conformation
Pedigree
Movement

5. What age are the horses that you buy for the sport?
If more than one category applies, please tick the most commonly used category

0 – 2 years □ 3 years □ 4 years □ 5 years □

6 + years □ any age □

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6. In relation to Breed: What breeds do you consider the <u>most</u> suitable for eventing?

ISH □ ISH x XX(TB) □ XX(TB) □ SF □ KWPN □

German bred □, *please specify*____

Other □, *please specify*____

6 a. Irish bred: Which Irish crosses would you consider the ideal for the new format?

□	RID x XX	*please specify*	mare / stallion RID
□	ISH x XX	*please specify*	mare / stallion ISH (3/4 or 7/8 outcross)
□	ISH x Foreign	*please specify*	mare / stallion ISH
□	CP x ISH	*please specify*	mare / stallion CP
□	Other,	*please specify*____________________________________	

7. When you are buying event horses, where do you buy them?

Private Vendor □ Thoroughbred auction □ Sport horse auction □

Performance sales/auction, specialised sales □ All of the above □

Other □, please specify ____

8. How much money would you consider spending when purchasing a 3 year old horse that you would consider suitable for the sport? (€)

< 2,500 □ < 5,000 □ < 10,000 □ < 15,000 □

< 20,000 □ > 20,000 □

Conformation:

9. What aspect of conformation/movement do you think is most important to an event horse? (Rank in order of importance: 1 - most important and 6 - least)

Head and Neck	
Saddle position (Withers and Shoulder)	
Limbs	
Back	
Structure	
Hindquarters	

Other □, *please specify* ____

10. What do you consider ideal head and neck conformation?

Head/Neck connection	Light	0	0	**0**	0	0	Heavy
Neck/Body connection	Deep	0	0	**0**	0	0	Narrow
Length of Neck	Long	0	0	**0**	0	0	Short
Muscling of Neck	Upside Down	0	0	**0**	0	0	Topline

Other, *please specify* ____

11. What do you consider an ideal saddle position?

Withers	High	0	0	**0**	0	0	Flat
Shoulder	Straight	0	0	**0**	0	0	Sloping

Other, *please specify* ____

12. What do you consider an ideal front leg for the purpose of eventing?

Knee conformation	Back	0	0	**0**	0	0	Forward
Pastern	Sloping/long	0	0	**0**	0	0	Upright/short
Bone	Light	0	0	**0**	0	0	Strong

Other, *please specify* ____

13. What do you consider an ideal back leg?

Gaskin	Weak	0	0	**0**	0	0	Strong
Muscularity of Quarters	Poor	0	0	**0**	0	0	Strong
Hock	Straight	0	0	**0**	0	0	Sickle

Other, *please specify* ____

14. What do you consider ideal feet?

Foot	Wide	0	0	**0**	0	0	Narrow
Heels	High	0	0	**0**	0	0	Low

Other, *please specify* ____

15. What do you consider an ideal back for the event horse?

Length of Back	Long	0	0	**0**	0	0	Short
Shape of Croup	Sloping	0	0	**0**	0	0	Flat
Loins/Muscling	Strong	0	0	**0**	0	0	Weak

Other, *please specify* ____

16. What do you consider an ideal structure?

Shape	Rectangular	0	0	**0**	0	0	Square

Other, *please specify* ____

Movement:

17. What so you consider an ideal walk?

Length of stride	Short	0	0	**0**	0	0	Long
Correctness	Toed in	0	0	**0**	0	0	Toed out

Other, *please specify* ____

18. What do you consider an ideal trot?

Length of Stride	Short	0	0	**0**	0	0	Long
Impulsion	Weak	0	0	**0**	0	0	Powerful
Deviation	Dishing	0	0	**0**	0	0	Plaiting

Other, *please specify*____

19. What do you consider an ideal canter and gallop?

Length of Stride	Short	0	0	**0**	0	0	Long
Impulsion	Weak	0	0	**0**	0	0	Powerful

Other, *please specify*____

20. What type of abnormalities in conformation do you consider a hindrance in the sport?

____
____
____
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21. When buying an event horse: What are your criteria for selection?

Appendix 2 Subject Information Sheet

University of Limerick

Soraya Morscher and Sean Arkins

"Selection Criteria For Three Day Event Horses In Ireland"

- What is the study about?

Selection criteria for event horses need to be different than those for dressage or jumping horses as the horse needs to be able to negociate all the disciplines at top level. To identify elite horses early, stud books all over the world use conformation as an indicator for pre selection and suitability. FEHL in Ireland are providing an ideal ground for young horses to prove themselves and showcase their potential. To find out exaclty what is ideal conformation for an elite event horse very little studies have been carried out and non based on Irish breeds.

- What will I have to do?

Briefly answer 21 questions in relation to event horse selection.

- What are the benefits?

To help Irish breeders identify early on whether the product they are breeding is up to international standard. Furthermore to provide breeders with the information on what type of conformation and breeding is desired in the light of the new short format competition.

- What are the risks?

None

- What if I do not want to take part?

This questionnaire is based on voluntary participation, therefore if you decide not to take part there are no implications.

- What happens to the information?

It will be statistically analysed and any references to personal details will be kept confidential by coding the data and only the persons named above will be able to access this information.

- Who else is taking part?

Riders and trainers at elite level of eventing.

- What happens at the end of the study?

The information is kept for a period of ten years and then destroyed.

- What if I have more questions or do not understand something?

Contact name and number of the project investigators are provided below.

- What happens if I change my mind during the study?

You can at any stage decide to withdraw and any of the information provided will be deleted permanently.

- Contact name and number of Project Investigators:

Prof. Sean Arkins
Department of Life Science
University of Limerick
Limerick
061 213101

Soraya Morscher
Department of Life Science
University of Limerick
Limerick
061 213044

- *This study has been approved by the ethics committee of the Physical Education & Sport Sciences Department (PESSREC 30/08). However, if you still have concerns about this study and wish to contact someone independent, you may contact The Chairman of the University of Limerick Research Ethics Committee, c/o Vice President Academic and Registrar's Office, University of Limerick, Limerick Tel: (061) 202022.*

Appendix 3 Declaration Forms

"Selection Criteria For Three Day Event Horses In Ireland"

I have read and understood the **subject information sheet**.

I understand what the project is about, and what the results will be used for.

I am fully aware of **all** of the procedures involving myself, and of any **risks and benefits** associated with the study.

I know that my participation is voluntary and that I can withdraw from the project at any stage without giving any reason.

I am aware that my results will be kept confidential.

Date:__________ Signature:______________________________

Appendix 4 Descriptive Trait Graphs

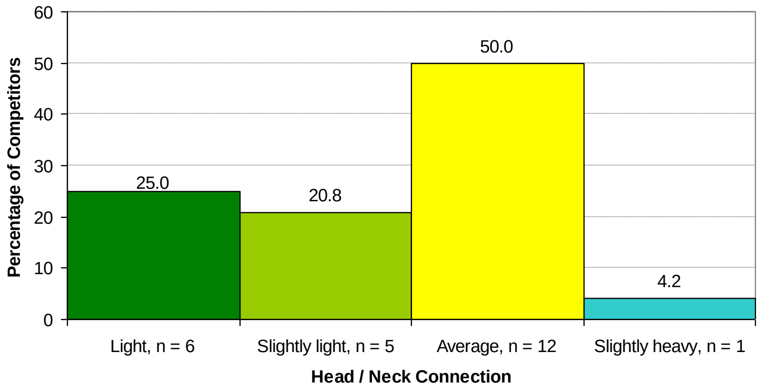

Figure 89: Opinions of Competitors on Ideal Head-Neck Connection for Event Horses

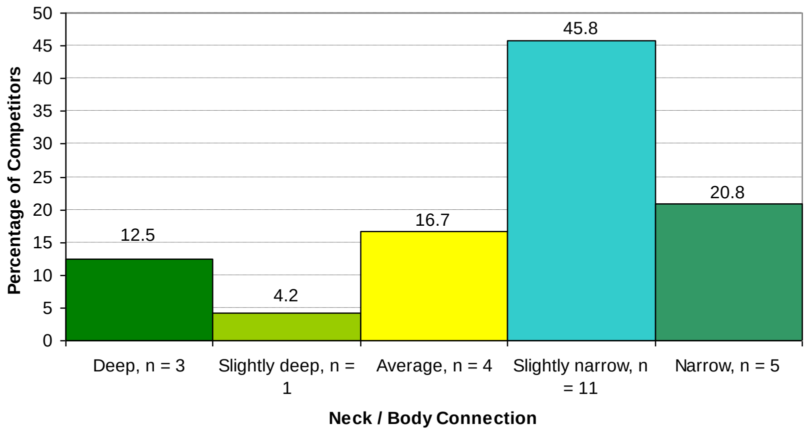

Figure 90: Opinions of Competitors on Ideal Neck-Body Connection for Event Horses

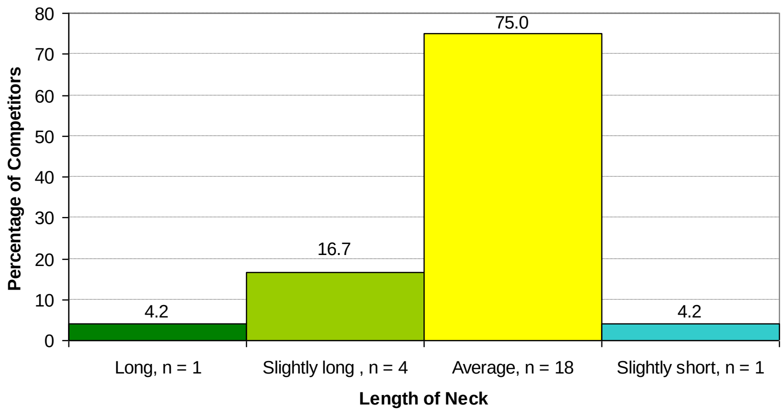

Figure 91: Opinions of Competitors on Ideal Neck Length for Event Horses

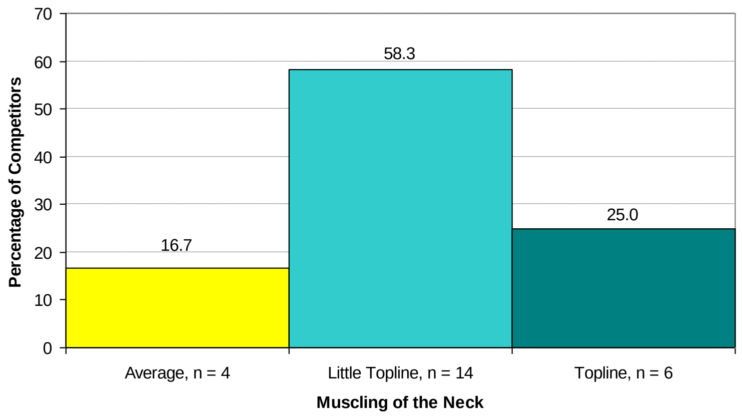

Figure 92: Opinions of Competitors on Ideal Muscling of the Neck for Event Horses

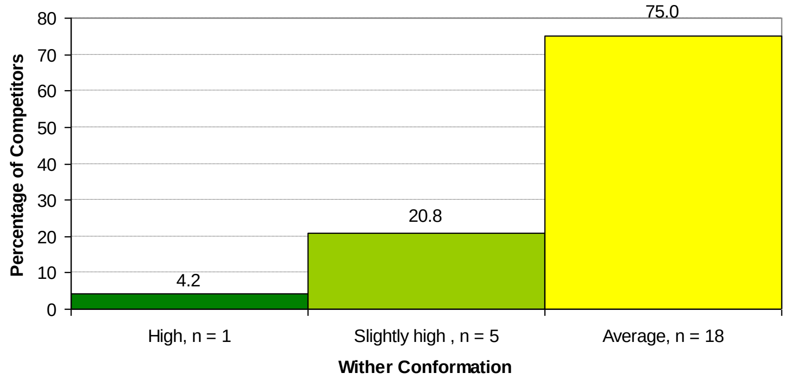

Figure 93: Opinions of Competitors on Ideal Wither Conformation for Event Horses

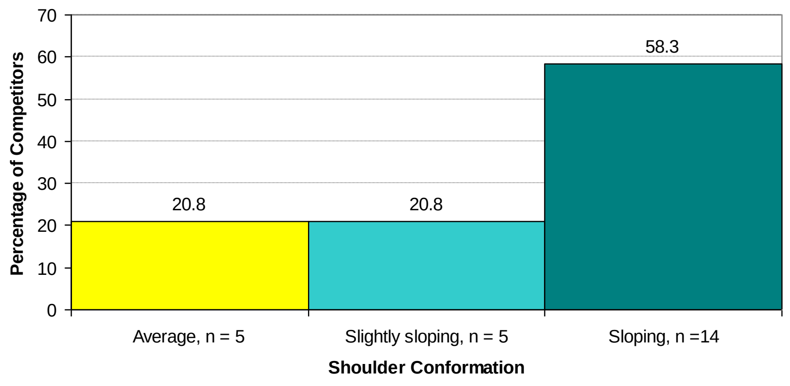

Figure 94: Opinions of Competitors on Ideal Shoulder Conformation for Event Horses

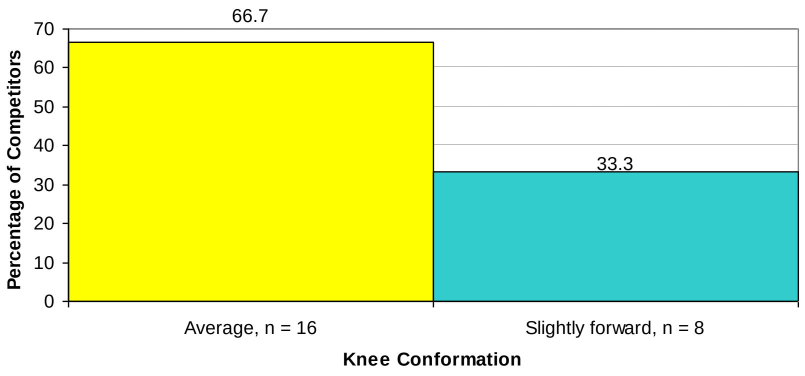

Figure 95: Opinions of Competitors on Ideal Knee Conformation for Event Horses

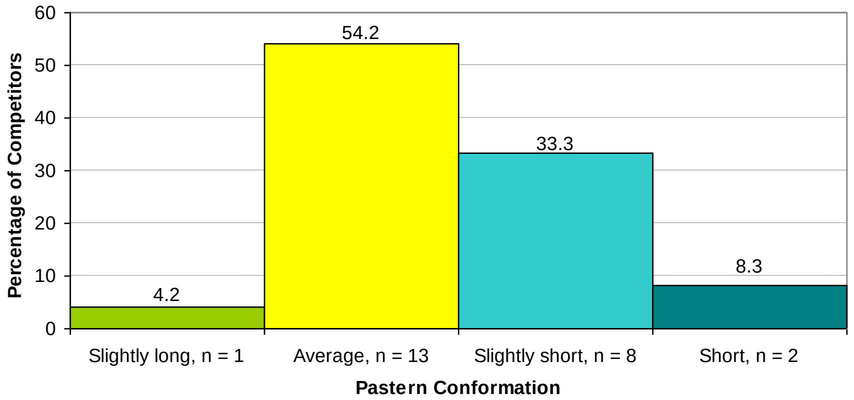

Figure 96: Opinions of Competitors on Ideal Pastern Conformation for Event Horses

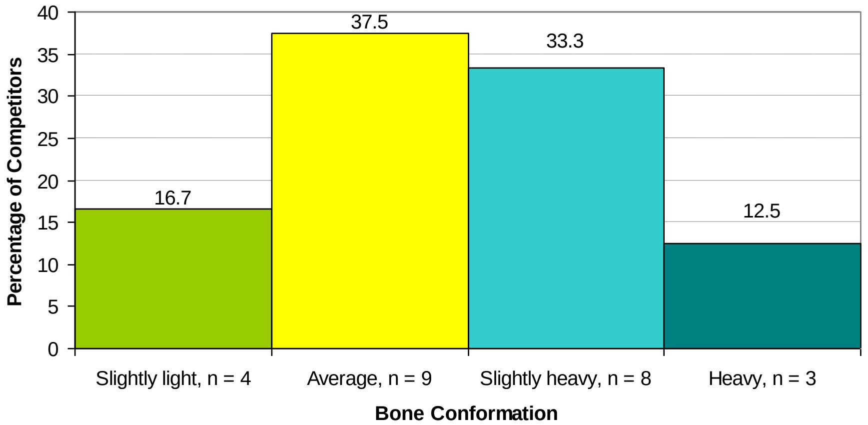

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Figure 97: Opinions of Competitors on Ideal Cannon Bone Conformation for Event Horses

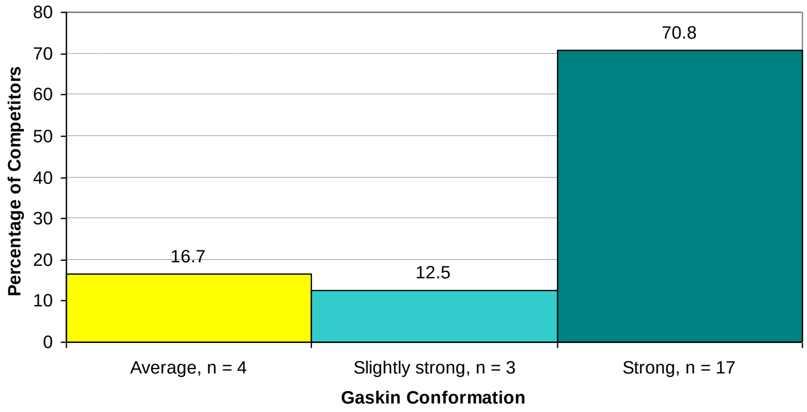

Figure 98: Opinions of Competitors on Ideal Gaskin Conformation for Event Horses

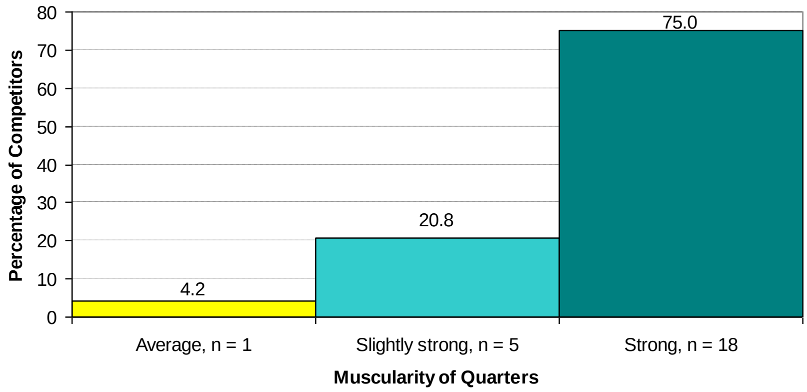

Figure 99: Opinions of Competitors on Ideal Muscularity of the Quarters for Event Horses

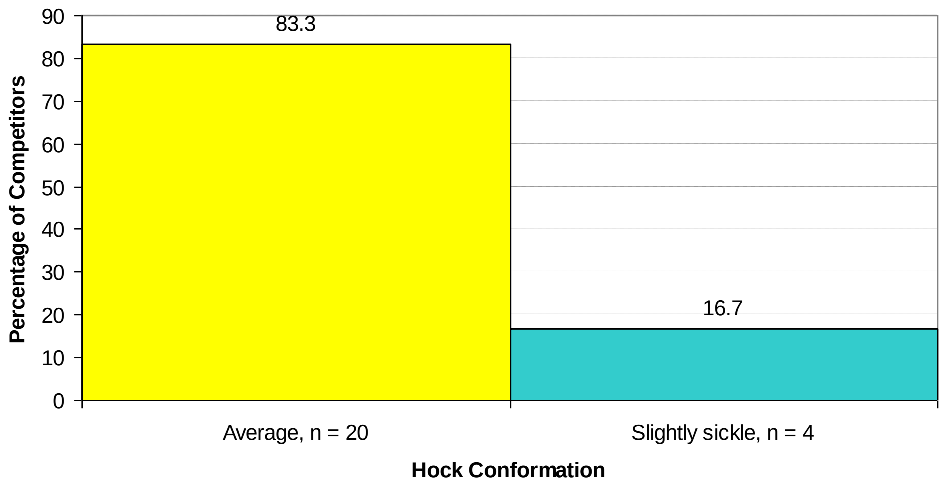

Figure 100: Opinions of Competitors on Ideal Hock Conformation for Event Horses

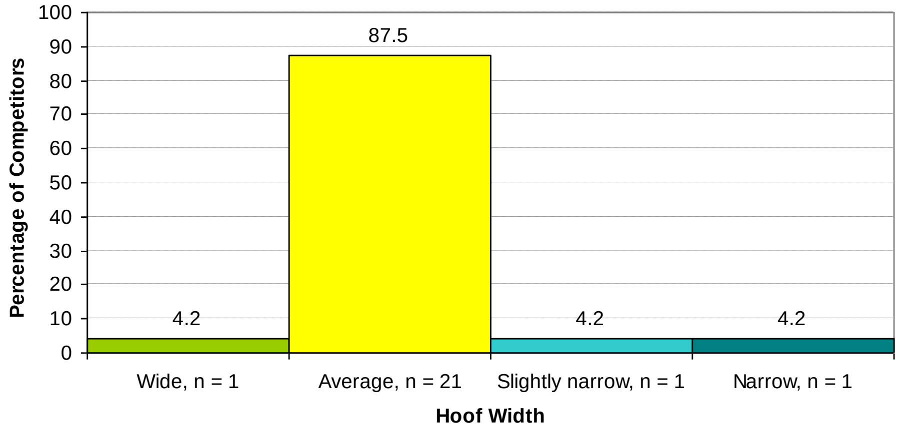

Figure 101: Opinions of Competitors on Ideal Hoof Width for Event Horses

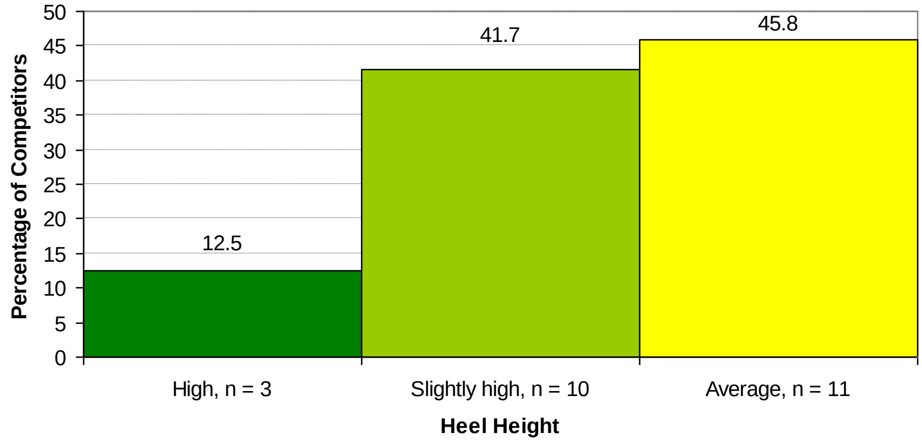

Figure 102: Opinions of Competitors on Ideal Heel Height for Event Horses

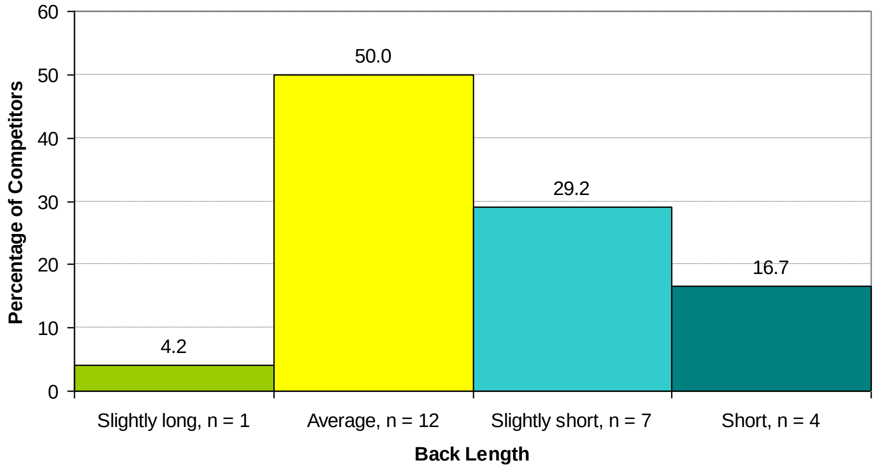

Figure 103: Opinions of Competitors on Ideal Back Length for Event Horses

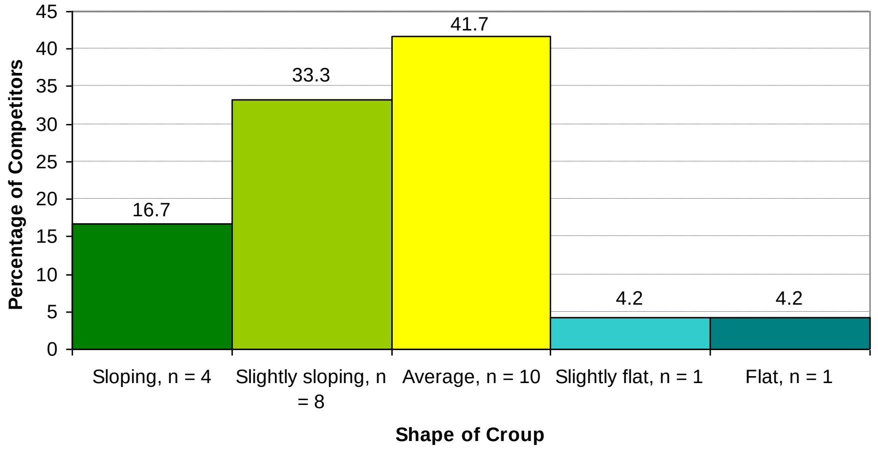

Figure 104: Opinions of Competitors on Ideal Shape of Croup for Event Horses

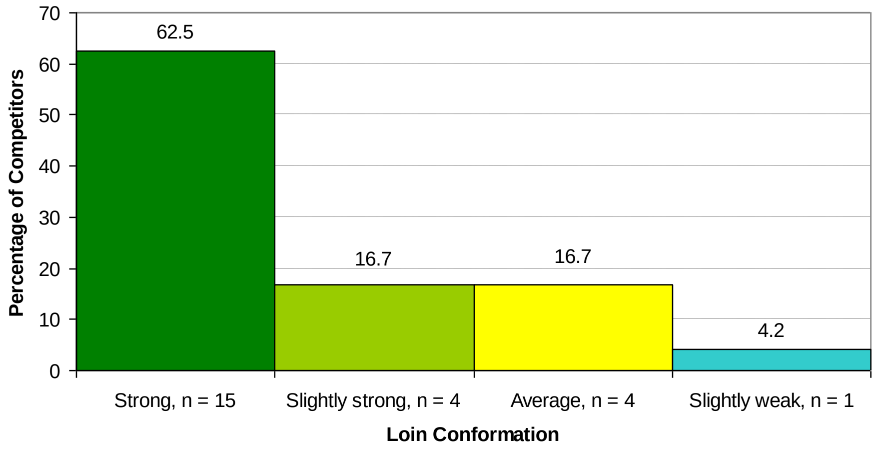

Figure 105: Opinions of Competitors on Ideal Loin Conformation for Event Horses

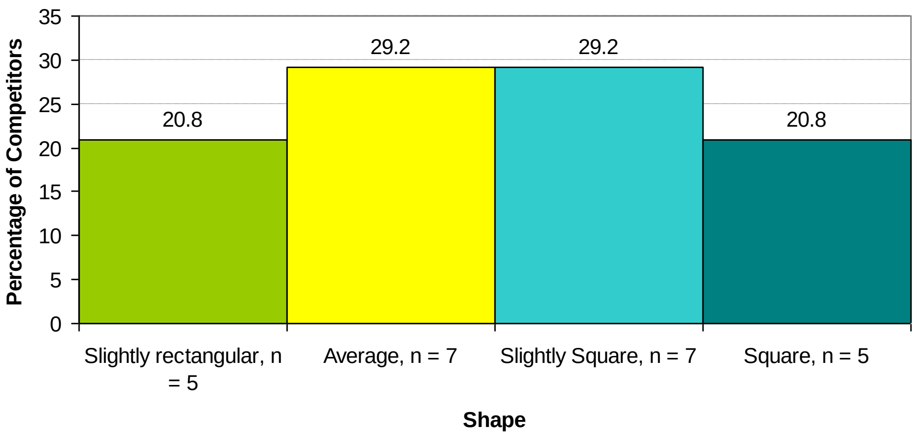

Figure 107: Opinions of Competitors on Ideal Shape/Structure for Event Horses

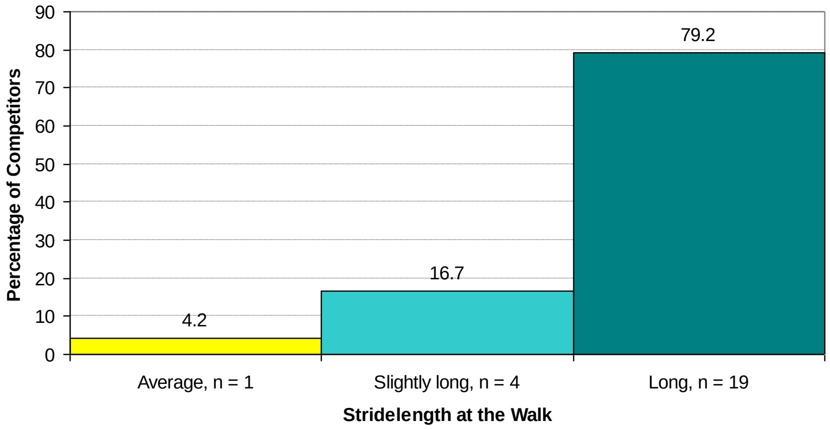

Figure 108: Opinions of Competitors on Ideal Stride Length at the Walk for Event Horses

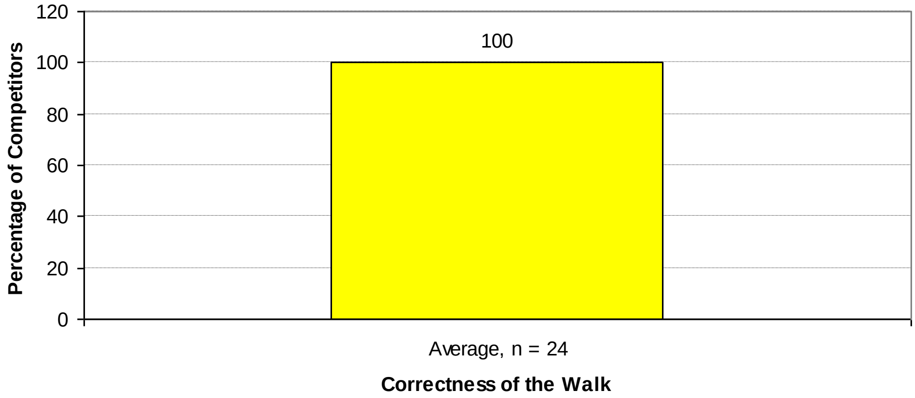

Figure 109: Opinions of Competitors on Correctness of the Walk for Event Horses

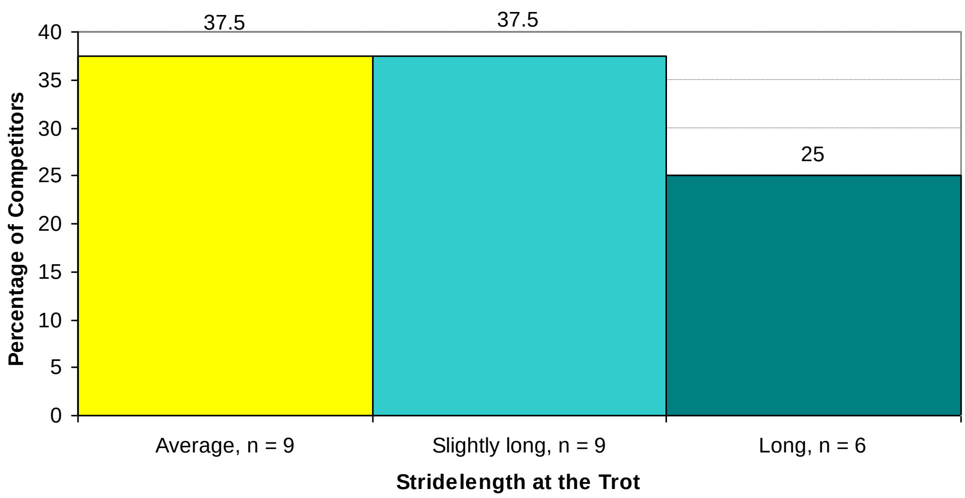

Figure 110: Opinions of Competitors on Ideal Stride Length at the Trot for Event Horses

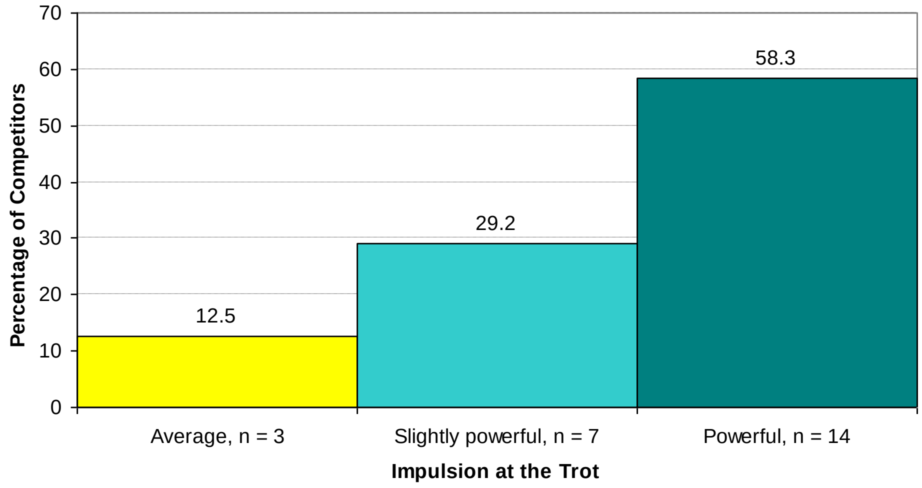

Figure 111: Opinions of Competitors on Ideal Impulsion for the Trot for Event Horses

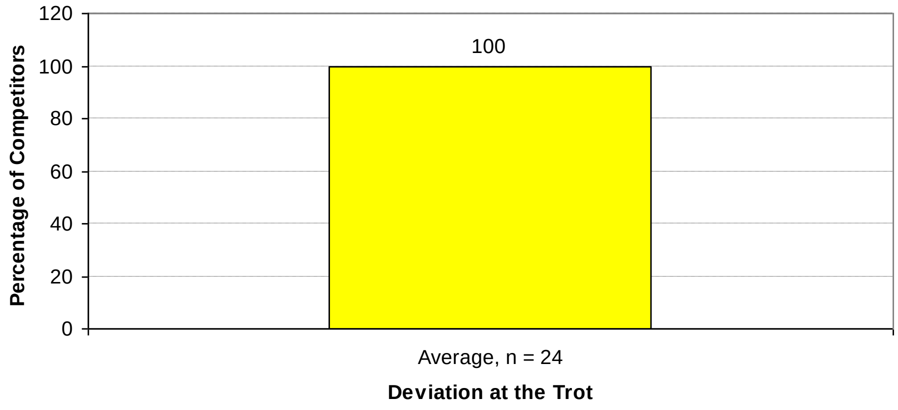

Figure 112: Opinions of Competitors on Correctness of the Trot for Event Horses

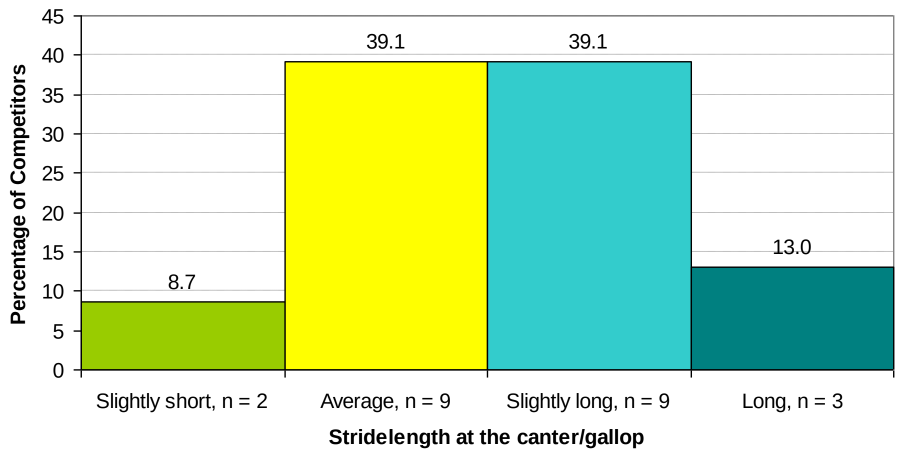

Figure 113: Opinions of Competitors on Ideal Stride Length at the Canter for Event Horses

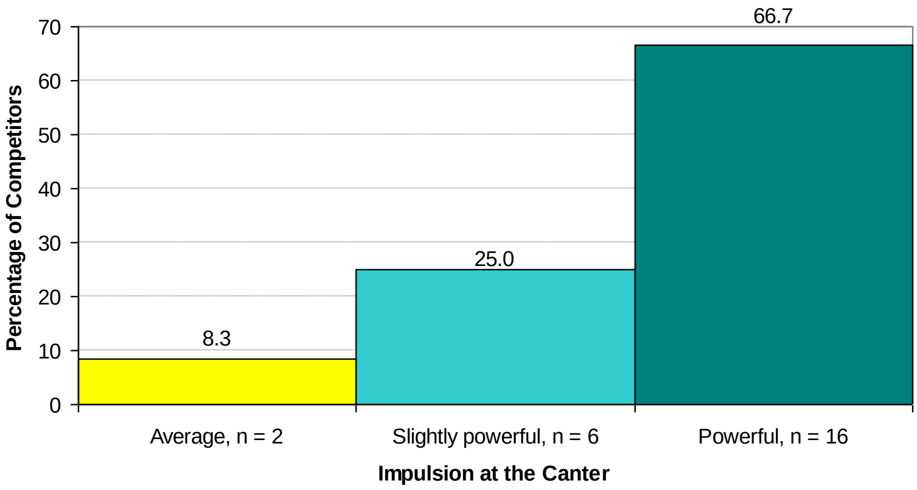

Figure 114: Opinions of Competitors on Ideal Impulsion for the Canter for Event Horses